United States
Department of
Agriculture

Forest Service

Volume 51, No. 4
1990

Fire Management Notes

Fire Management Notes An international quarterly periodical devoted to forest fire management

United States Department of Agriculture

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Front Cover: Firefighters in protective clothing fight to save structure in wildland.

Short Features

Fire Management Notes is published by the Forest Service of the United States Department of Agriculture, Washington, DC. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department.

Subscriptions may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Send suggestions and articles to Chief, Forest Service (Attn: Fire Management Notes), P.O. Box 96090, U.S. Department of Agriculture, Washington, DC 20090–6090.

Wildland-Urban Interface Emergency Responses: What Influences Them?

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Introduction

The wildland firefighters' job is changing, in large measure from problems associated with the wildland-urban interface. More development is occurring at the edge of forest boundaries, on tracts of private land within forest boundaries, and in metropolitan areas within easy drives of the forest. There are more residents, more tourists, and increased values at risk. Wildland firefighters are increasingly encountering structural fires and other nonwildland fire emergency assistance situations.

Historically, it has been common practice for wildland firefighters in the USDA Forest Service to respond to reported structural fires, vehicle fires, vehicle accidents, and other situations where emergency assistance is required. However, the frequency of these situations is increasing as interface pressures intensify. There are concerns that wildland firefighting resources are being committed to structural protection at the expense of wildland resources. Moreover, managers, crews, and cooperators are concerned whether their wildland training and equipment adequately prepare them to deal with the increasing and varied emergency response situations they now face.

Questions have also been raised that perhaps it is the complex set of cooperative and mutual aid agreements with State and local fire and emergency response organizations that are placing personnel in nonwildland fire situations. Do the agreements have explicit provisions or create informal expectations that wildland organizations will move beyond their traditional wildland firefighting role?

These concerns, highlighted by the serious interface fire events of recent years, led the Forest Service to undertake a policy analysis examining these issues. The study examined agency policy and the actions forests have taken or anticipate will be taken, to respond, equip, and train in the areas of structural fire, search and rescue, emergency medical assistance, and hazardous materials.

Who is to speak on behalf of those resources when decisions are made to permit urban expansion in the interface?

To conduct the study, a joint Forest Service-University of Arizona study team visited 16 national forests throughout the country. One-half of the forests was randomly selected, one from each Forest Service administrative region except Alaska. The other half was selected to represent a geographical diversity as well as a diversity of interface situations. Overall, the 16 forests varied widely in the size of their fire programs, budgets, workforce organization, and complexity of cooperative arrangements. The site visits, conducted between October 1989 and February 1990, lasted approximately 1½ days. During the first day, roundtable discussions were held with selected district and forest personnel from all levels of the forest organization—from first responders to members of the management team. On the second morning, another roundtable discussion was held with personnel from other Federal, State, and local resource management agencies and public safety organizations. In total, approximately 230 Forest Service employees and 100 cooperators were interviewed.

This article examines five factors the study concluded influenced the type and level of response national forests make to structural fire and other emergency assistance situations. The five factors are: presence, public expectations, agreements, suppression priorities, and national mobilization.

Presence

There are two kinds of presence to consider: the presence and capabilities of the Forest Service and the presence and capabilities of the local emergency assistance organizations. In many remote districts, there is no organized fire protection. In this "no man's land," the Forest Service is the only fire department. Structures present a threat to wildlands, and the Forest Service is the only one there to respond. Moreover, even if the agency's capability is limited and in reality not much can be done to save the structure, there is still a need to respond; to do otherwise would risk public censure. This need even transcends meeting the test that says response should be related to a "threat to the national forest." Consequently, on one forest, personnel reported responding to a structural fire even when there was a foot of snow on the ground.

Many kinds of emergencies involving vehicles and individuals—traffic collisions, shootings, falls, and lost children—can occur on or near wild-

lands. Forest Service stations represent authority and signify official help. Stations along a highway, especially in areas distant from any other official-looking organization, are the natural, first choice for anyone seeking help. Government personnel and facilities represent telephones and radios, answers, and assistance.

In areas where there may be locally organized capabilities, Forest Service presence can still necessitate a response. If a Forest Service engine looks like a fire truck—lights, hose, and sirens—and acts like a fire truck, to the public, it is a fire truck. The public does not distinguish among the color of trucks and draw conclusions about which color truck belongs to which agency and the different roles and capabilities of trucks and crews. Most forest personnel recognize this and understand the need to make a response. They do respond and do what they can to fight the fire or medically assist the injured, even if they believe their actions may be outside of policy. To say it's another truck's responsibility would be unacceptable. The Michigan Department of Natural Resources learned this the hard way when personnel failed to respond to a structural fire as requested. As a result of the political fallout, the State legislature added structural responsibilities to the department's mission.

One alternative, perhaps, is to minimize the appearance of being an all-risk fire organization (trained and equipped to respond to all types of hazardous emergencies and to render medical assistance). One forest with a significant fire interface problem did not have any engines. They felt that that fact helped to keep them out of the vise of public pressure.

Another way to reduce presence might be to use contracts and agreements to turn over responsibilities to local authorities. Generally, however, forests did not believe this would be a good idea. Several felt it was a politically infeasible option, particularly in local areas. "This wouldn't fly!" and "It would be the second dumbest thing we ever did, and I can't remember the first!" were two of the comments heard at the site visits. Other responses citing disadvantages to this option focused on the need for a wildland fire organization for national mobilization and prescribed fire activities, the high cost of contracting, and the loss of ability to direct strategies and tactics based on natural resource concerns. Nevertheless, several individuals expressed a preference for this option, especially in areas where there are full capability fire organizations and where public expectations are for a full all-risk response.

Cooperator organization and capability are also part of presence. In some instances, areas may be covered by local organizations, but their training and capabilities may be limited. The telephone for the volunteer department may be in the rear of the local grocery store and unstaffed at night. In some areas, local volunteers showing up poorly equipped at a wildland fire threatening or involving structures present safety problems to the Forest Service. Decisions must be made about how to balance safety and volunteer efforts. Failure to be sensitive about community needs and desires to be involved has, on more than one occasion, created needless controversy and political headaches.

On the other extreme, the local organization may be a professional and well-trained and -equipped outfit. Generally, the more sophisticated the local responder, the less the perceived need for the Forest Service to become involved in structural firefighting. Local responders are often first on the scene. During incidents, responsibilities are divided between structures and wildlands; the local entities fight the structural fire and the Forest Service defends the wildlands. In many areas, local entities want to become more proficient in wildland firefighting techniques, because they are often the first responder to wildland incidents and they now have residences in the wildland interface to protect from advancing wildfires.

Another consequence, however, of cooperating with well-trained and -equipped structural firefighting or all-risk units is that their level of expertise and sophistication may begin to drive Forest Service desires to reach the same level of competence.

Public Expectation

To the public, a firefighter is a firefighter. The public does not understand the difference between wildland and structural firefighting and that individuals typically trained in one kind of firefighting are not trained in the other or that the equipment carried and used for each kind of incident is different. In an emergency, the public expects help, and government officials in uniform or dressed as emergency personnel are looked to for help.

When residents of a large metropolitan area visit a forest, it is unlikely they realize that the level of emergency service is different than what they left behind just a few miles or hours away. New residents in forested areas are increasingly bringing with them the expectation about fire protection and emergency service they left behind in the city. They expect the local government representative to provide them fast, efficient, and professional emergency service. But as one Forest Service employee noted, "Here, when someone calls 911, the phone doesn't ring." The obligation and expectation to respond is therefore directed to the only other visible official presence—the Forest Service.

As part of their professional duties, Forest Service personnel have traditionally been expected to be an active part of the community. This has been part of the ethic of the agency, underscored in the reward system, documented by studies such as Herbert Kaufman's "The Forest Ranger" (1960), and glamorized in television series like "Lassie" and films like "Always." On the one hand, community involvement presents informal and effective opportunities to educate local leaders and residents about the Forest Service role and the limits to Forest Service capabilities. Yet, there are mixed signals. While the benefits of civic service are acknowledged and touted by management, no one in management wants the local ranger to give away the store. So there are also messages not to overcommit finances or organizational resources to civic service. Knowing where to draw the line can be difficult. Also assuming that the agency or the individual can singularly draw the line may be a flawed assumption. Once enmeshed in the traditions and mores of a local community, defining civic duty and civic obligation is a community function.

It is politically rational behavior for communities and individuals to avoid assuming costs if the costs can be passed off to some other party—especially the government. Developers do not want to assume additional costs of designing fire-safe environments or structures if the costs can be avoided or passed off to the homebuyer. Homeowners do not want to assume the costs of protection for living in a hazardous environment if the costs can be passed off to the government (Gardner et al. 1987). To the extent government responds or absorbs some of the costs, this represents an indirect subsidy to the interface homeowner.

What Was Said? Here Are Some Quotations

"When it is a close community that you are part of and friends and neighbors are urging that something be done, it is hard not to push yourself."

"It's more complex now. Because we are dealing with homeowners and more values at risk, there is more to think about in terms of strategies and tactics."

"If you go life, property, and then natural resources, you never get to the resources."

"We are part of the community and cannot refuse to assist."

"When you're the only light for miles, people knock on your door for help."

"If we don't respond to a call, we are not fulfilling the agency's mission of serving the people."

"People are trapped between policy and political and moral situations."

"The forest is being forced into situations where structures are encountered, just like county agencies are being forced into wildland firefighting."

"The Forest Service is beyond the point of standing alone."

"We cross boundaries as if they aren't there."

Agreements and Cooperation

With or without formal cooperative agreements, forests are using the "closest forces" concept in response

to emergencies—the unit closest to the incident responds regardless of jurisdictional boundaries. In areas of intermixed ownership or of developments surrounded by national forest land, this means that the Forest Service truck may be the closest unit to many structural fires and other emergency situations. The closest forces concept implies coverage of non-National Forest System land. It also means that structural entities may be the first to respond to a wildland incident and the agency benefits from this. Thus, not surprisingly, one frequently cited benefit of the cooperative agreement is that it allowed the closest forces concept to work. Nonetheless, as practiced, closest forces do increase the likelihood that Forest Service units and crews will be responding to nontraditional fire incidents and other emergency situations.

When, in December of 1989, the agency authorized forests to acquire self-contained breathing apparatus for use in situations where smoke from structures, vehicles, or dump fires involved hazardous materials, it recognized that acquiring such equipment could move the agency beyond its traditional wildland roles and responsibilities. A letter advising agency personnel about the new policy cautioned: "One way to reduce the exposure of Forest Service employees to non-traditional emergencies upon our wildfire suppression capacity is to minimize our obligations to protect non-National Forest System land, particularly developed lands, to the extent feasible and practical."

This enjoinder, however, conflicts in reality with the direction the agency has been taking; the pendulum is swinging the other way. Obligations to be involved in fire protection and suppression activities outside forest boundaries are increasing. Cooperative arrangements are becoming more numerous, comprehensive, and complex. The basic premise of the National Wildfire Coordinating Group (NWCG), which was initiated by the Forest Service, is "better fire management through cooperation." The agency's Wildland-Urban Fire Protection Initiative has expanded and furthered cooperation by embracing the National Fire Protection Association as a cooperating partner, which brings in the structural fire community. Partnerships have been promoted in virtually all aspects of Forest Service management, and Forest Service-sponsored publications promote "building interagency cooperation" (Swinford and Tokle 1988). Both cooperators and forest personnel believe there is no going back. To survive, both entities need each other.

An agreement with a provision for moving to and covering another agency's station when it is on-call (move up and cover) potentially places Forest Service personnel in situations they are not trained, equipped, or inclined to encounter. In most instances because cooperators understand the agency's capabilities and limits, they avoid trying to put agency personnel in such situations. Nevertheless, agency personnel have been put in such situations. Moreover, the inability of the Forest Service to fulfill the responsibilities implied by a move-up-and-cover provision can create potential problems for the cooperating entity. What happens when a local citizen calls the local station and the responding unit and individuals are not equipped or trained to assist? The cooperator, not the Forest Service, is likely to receive the political fallout. The move-up-and-cover provisions on the three forests visited in one State were a sore point between the cooperator and the agency.

Partnership is not cost free. While there are many benefits, there are costs that should be explicitly recognized and accounted for. To foster the spirit as well as the letter of cooperation, personnel often need to go beyond what is legally required. There must be a demonstrated willingness to help out in situations where there is no threat to National Forest System lands, for example. Doing the job and then working things out afterward is in the spirit of cooperation. A hesitancy to act because it may later be discovered that the incident did not occur within the forest's protection boundary or because it is unclear how the costs will be divided is not seen as cooperation, but as bureaucratic entrenchment. There is a price to partnership—taking risks, stretching policy, and maintaining operational and fiscal flexibility.

Suppression Priorities

Agency policy does not specifically identify wildfire suppression priorities. There is no explicit policy stating that agency priorities are life, property, and then resources. Nevertheless, the fire planning and analysis system and the fire suppres-

sion priorities established in operational guides lead to this determination. So do policy interpretations by agency leadership (Davis 1990).

Because of the growth of the interface, concerns have been raised about the implications that adherence to this policy may entail. As one forest commentator indicated, "If you go life, property, and then natural resources, you never get to the resources." One significant issue concerns the level of natural resource losses that might occur as fire suppression resources or personnel are diverted from high-valued natural resource areas to the defense of structures—regardless of their value. As the interface grows, the situation becomes ever more problematic.

Because of its concern over this issue, the State of Oregon recently restated the suppression priorities for its State forestry department during wildland fire situations. They are: life, resources, and property. On the other hand, the Michigan legislature added structural firefighting to the responsibilities of its natural resources department. If States are, as Supreme Court Justice Brandeis once commented, great laboratories for experiments, the messages received from these two States provide no clear clue as to the feasibility of reaffirming or revising the Forest Service's de facto policy in this regard.

The question that arises is who is to be the guardian of the natural resources? Who is to speak on behalf of those resources when decisions are made to permit urban expansion in the interface? On the one hand, being a good neighbor may mean eschewing the appearance of dabbling and interfering in the affairs of local communities. On the other hand, not taking action to prevent the creation of hazardous interface situations may be placing costs on the Nation's taxpayers as well as harming the Nation's natural resources. To what extent does the professional manager's charge to manage and protect the public's lands entail managing threats from beyond the boundary? Like the adage that good fences make good neighbors, it may be consistent with a good neighbor policy to prevent hazards from being created and to provide incentives for local communities and residents to redeem their responsibilities. Actual experience may prove that Oregon's decision to reaffirm the primacy of natural resources over property in its wildland suppression priorities is infeasible (which we believe will occur). If so, preventive actions to minimize the number of situations in which such choices have to be made may be the only feasible and prudent policy option.

Finally, as Federal health and safety requirements are tightened to protect workers from hazardous situations, it is likely that training and equipping standards will not be defined just by the agency but also by external sources. Such sources could include the Occupational Safety and Health Administration and the National Fire Protection Association (the recognized authority for the development of industry standards for firefighter health and safety).

National Mobilization

No matter how well interface responsibilities have been worked out in a community, personnel are traveling to other areas of the country where they report encountering structural situations as well as a vast array of other emergency incidents—dump fires in New Jersey, earthquakes in San Francisco, and oil spills in Alaska. Experience from the Greater Yellowstone Area fires where crews spent their entire time protecting "a barn and a corral" is still fresh in people's memories. While individual forests may not see the need for training in structural fire situations at home, they see the need to be prepared for the situations encountered off-forest.

The Incident Command System (ICS) is also perceived as promoting the ability of personnel to take their skills and apply them to a whole range of emergency and disaster situations. The Forest Service has played a leadership role in the formulation and dissemination of the ICS. Expectations exist that it will continue this role. "It is after all," commented one employee, "called the incident, not the fire, management system."

Conclusion

As the existing wildland-urban interface expands and new interface is created, there will be more structural fire and other emergency assistance incidents, especially in rural areas, where the Forest Service is a key emergency response unit. Policy revisions and clarification and innovative management actions will be needed to ensure that the agency is able to fulfill its primary wildland fire suppression and resource protection responsibilities, while it also

responds to the changed social and institutional environment represented by the wildland-urban interface.

Options to reduce presence and minimize public expectation will need to be explored. While it is highly unlikely that fire suppression priorities or national mobilization practices will (or should) be changed, minor modifications in implementation can help reduce presence and mitigate some of the adverse consequences when crews are exposed to hazardous interface situations. For example, fire analysis and planning procedures, operational guides, and training courses for incident management teams can emphasize decisionmaking under risk that is sensitive to resource values as well as to the political and human realities of human life and property.

Finally, cooperation and mutual aid agreements are part of the problem and part of the solution. On the one hand, provisions that place the agency in hazardous nonwildland fire emergencies can be avoided. Agreements can be more closely evaluated to ensure that expectation, role, and responsibility are clear, and that the resulting relationships are effective and financially and politically equitable. On the other hand, because of reduced budgets and personnel cutbacks in all sectors, cooperation has become a political imperative. Cooperation among all emergency response organizations at all levels of government will be needed to prevent, plan for, and respond to interface emergencies. ■

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Incident Business Management Coordinator Positions

Incident business management coordinator positions have been established in the Washington Office and the offices of each region and the Northeastern Area State and Private Forestry. People in these positions coordinate the full range of business management support needs for incidents. They are primary contact points for tackling issues and resolving problems arising from the administrative support for emergency response operations. Contact with any of the coordinators listed below provides access to the entire network—for dealing with preseason issues and serving as a hotline for urgent problems as well as their other business management support activities. The coordinators can rapidly share information about unusual situations. See table 1 for a list of the Forest Service coordinators and information on how they can be reached. ■

William G. Bradshaw, *Incident business management coordinator, Fiscal and Public Safety Staff, Washington, DC*

Table 1—*Forest Service coordinators*

Region	Name	DG address	Telephone number
Region One	Mike Ramos	M.Ramos:R01A	(406) 329–3331 FTS 585–3331
Region Two	Peter Gilmour	P.Gilmour:R02A	(303) 236–9575 FTS 776–9575
Region Three	John Coil	J.Coil:R03A	(505) 842–3185 FTS 476–3185
Region Four	Tina Ledger	T.Ledger:R04A	(801) 625–5805 FTS 586–5805
Region Five	Virginia Clark	V.Clark:R05A	(415) 705–2573 FTS 465–2573
Region Six	Arnie Masoner	A.Masoner:R06A	(503) 326–6580 FTS 423–6580
Region Eight	Gerald Tyler	G.Tyler:R08A	(404) 347–2659 FTS 257–2659
Region Nine	Harlan Smid	H.Smid:R09A	(414) 297–3625 FTS 362–3625
Region Ten	Teresa McAlister	T.McAlister:R10A	(907) 586–8731 FTS 586–8731
Northeastern Area State and Private Forestry	Jack Horton	J.Horton:S24A	(215) 975–4147 FTS 489–4147
Washington Office	Bill Bradshaw	B.Bradshaw:W01B	(703) 235–9698 FTS 235–9698

The Haines Index and Idaho Wildfire Growth[1]

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Introduction

The growth of wildfires is related to three broad factors: fuel type, topography, and weather. The National Fire Danger Rating System and the Fire Behavior Prediction System combine these factors to predict the probability and severity of wildland fires. However, these systems have mixed results in predicting extreme fire behavior conditions characterized by intense crowning and spotting. Extreme fire behavior is rare, but when it occurs, fires burn with intense heat and spread rapidly, endangering life and property.

An atmospheric index, the Lower Atmospheric Severity Index (LASI) developed in 1988 by Donald Haines, a research meteorologist with the USDA Forest Service, addresses the problem of how weather promotes extreme fire behavior conditions. This index uses the environmental lapse rate (temperature difference) within a layer of air coupled with its moisture content to determine a LASI number.

This paper compares the values of LASI or the Haines Index, as we will call it, with what occurred on recent large Idaho fires in an attempt to determine its predictive capabilities with regard to large fire growth.

Extreme fire behavior, with crowning and long-range spotting, was exhibited by the fire when the Haines Index number was 5 or 6. But when the index lowered to 4 or less, fire activity significantly diminished.

Haines Index—Background Information

Research conducted earlier on fires in the Eastern United States had identified unstable air and low moisture as major contributors to fire severity. Haines contacted wildland fire management units throughout the country requesting information on their worst fire situations over a 20-year period. Information was received from 30 States regarding 29 major fires in the West and 45 fires in the East. Data from one to three radiosonde stations closest to each fire were examined to determine airmass lapse rates and moisture values over the fires. (Radiosonde weather stations launch instrumented balloons that measure atmospheric temperature, relative humidity, pressure, and wind.) The 0000 GMT/1800 MDT temperature and dewpoint profile for the evenings on which the fires were reported were constructed for one of three layers between 950 and 500 millibars (approximately 2,000 and 18,000 ft msl), depending upon the elevation of the fire. Due to large differences in elevation across the United States, three combinations of atmospheric layers were used to construct the LASI.

Figure 1 shows a map of the United States divided into three regional elevations. Much of the Eastern United States, excluding the Appalachian Mountains, uses a low-elevation index computed from 950–850 millibar data (approximately 2,000 and 5,000 ft msl). A mid-elevation index was developed for the Great Plains and the Appalachian Mountains using 850–700 millibar data (approximately 5,000 and 10,000 ft msl). A high-elevation index is used for the mountainous Western United States using 700–500 millibar data (approximately 10,000 and 18,000 ft msl).

Comparing large fires and nearby upper air data, Haines developed his Lower Atmospheric Severity Index, which indicates the potential for large fire growth. Temperature lapse rate—stability—and moisture values are combined, resulting in the Haines Index using:

$$\begin{aligned} \textit{Haines Index} &= \textit{Stability} + \textit{Moisture} \\ &= (Tp_1 - Tp_2) + (Tp_1 - Tdp_1) \\ &= A + B \end{aligned}$$

where T is the temperature at two pressure surfaces (p_1,p_2); and Tp_1 and Tdp_1 are the dry bulb temperature and dewpoint temperature at a lower level. All temperature values are written in centigrade.

Illustrated in table 1 are the lapse rate and moisture limits used in the low-, mid-, and high-elevation Haines indexes.

The Haines Index equals the sum of factor A (stability) and factor B (moisture):

Haines Index (A + B)	*Class of day (potential for large fire)*
2 or 3	very low
4	low
5	moderate
6	high

Haines found that only 10 percent of large fires occurred when the class

[1] A related article, "Evaluation of Idaho wildfire growth using the Haines Index and water vapor imagery," was published in the preprint of the proceedings of the Fifth Conference of Mountain Meteorology; 1990 June 25–29; Boulder, CO. Boston, MA: American Meteorological Society: 187–193.

of day was very low (Haines Index 2 or 3) though 62 percent of the fire-season days fell in the very low class. Forty-five percent of the fires were associated with the high-class days (Haines Index 6), while only 6 percent of the days fell in that class.

Instability and dry air are key parameters that must be present to result in a high Haines index number. Instability can be caused by either warming the lower levels of the airmass or by cooling the upper levels. When warming below and cooling aloft occur at the same time, the airmass rapidly destabilizes. In the Western United States, this occurs when cooling, associated with an upper trough of low pressure, moves over a surface thermal trough or "heat low." An increase in moisture usually accompanies the upper trough, but at times a "tongue" of very dry air wraps around the leading edge of the upper trough resulting in low relative humidities at the surface. Figure 2 displays a typical weather pattern that produces a high Haines Index in the Western United States: a thermal trough at the surface, a 500-millibar trough moving onto the West Coast, and a "tongue" of dry air across the Sierra Nevada Range into the Great Basin and Northern Rockies. This is the classic pattern associated with the "breakdown of the 500-millibar ridge." Nimchuk and Janz (1984) state that the breakdown of the 500-millibar ridge is clearly associated with severe wildfire behavior. However, not every "breakdown of the 500-millibar ridge" will produce extreme fire weather conditions—both instability and dry air must be present. Haines has addressed these two parameters in developing his index.

Figure 1—*Map of the United States divided into three regional elevations (Haines 1988).*

Table 1—*Stability and moisture limits in the low-, mid-, and high-elevation Haines indexes*

Elevation	*Stability term*	*Moisture term*
Low	950–850 mb °T	850 mb °T − dewpoint
	A = 1 when 3 °C or less	*B* = 1 when 5 °C or less
	A = 2 when 4–7 °C	*B* = 2 when 6–9 °C
	A = 3 when 8 °C or more	*B* = 3 when 10 °C or more
Mid	850–700 mb °T	850 mb °T − dewpoint
	A = 1 when 5 °C or less	*B* = 1 when 5 °C or less
	A = 2 when 6–10 °C	*B* = 2 when 6–12 °C
	A = 3 when 11 °C or more	*B* = 3 when 13 °C or more
High	700–500 mb °T	700 mb °T − dewpoint
	A = 1 when 17 °C or less	*B* = 1 when 14 °C or less
	A = 2 when 18–21 °C	*B* = 2 when 15–20 °C
	A = 3 when 22 °C or more	*B* = 3 when 21 °C or more

Idaho Wildfires and the Haines Index

The Haines Index is the first attempt to construct a formal fire-weather index based upon features of the lower atmosphere. Does it work? To answer that question, wildfires in central Idaho (fig. 3) were investigated in an attempt to correlate the Haines Index and large fire growth. One of these wildfires was the devastating Lowman Fire of late July and early August of 1989.

The Lowman Fire

The Lowman Fire was one of many fires that started on the Boise National Forest during an outbreak of

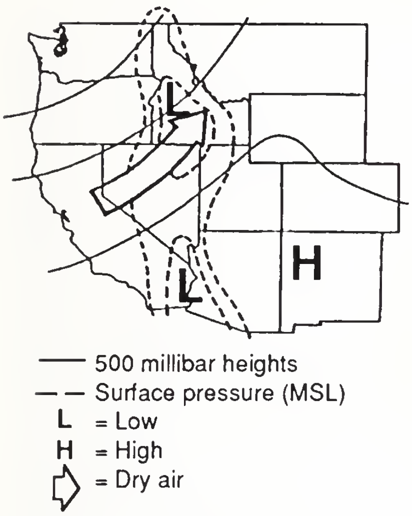

Figure 2—*Typical synoptic situation that produces a moderate to high Haines Index value.*

Figure 3—*Map of Idaho with wildfire locations.*

dry lightning on July 26, 1989. The fire spread only a short distance the following day, but by July 28, fire activity began to increase. Extreme burning conditions developed the afternoon of July 29. (See fig. 4.) Crowning and spotting pushed the fire 5.75 miles (9 km) to the northeast. The fire burned through the eastern edge of the small town of Lowman destroying 25 buildings and a number of vehicles and closing State Highway 21. All residents of Lowman were evacuated. Fortunately there were no injuries or deaths. The fire continued to spread toward the northeast during the next 3 days, but at a lower rate. Cooler temperatures and higher relative humidities moved over the fire August 2 with very little acreage lost after that date. The size of the Lowman Fire (over 46,000 acres or 18,616 ha), its extreme fire behavior, and the loss of homes and personal belongings will make the Lowman Fire one to remember for many years.

The rate of spread (ROS) exhibited by the Lowman Fire is plotted against the Haines Index in figure 5. On the morning of July 29 (from the 0600 MDT Boise radiosonde), the Haines Index number 6 (fig. 6) indicated a high potential for large fire growth. At approximately 1400 MDT, the fire made a rapid run toward the northeast at well over 75 chains (1,508 m) per hour. Temperature at the time was between 90 and 95 °F (32 and 36 C°) with the relative humidity as low as 8 percent. Surface winds were measured at 5 to 10 miles per hour (8 to 16 km/h) with occasional gusts to 15 miles per hour (24 km/h), but were much stronger near the fire front due to strong indrafts into the smoke column. For the next 3 days, the Haines Index fell to 5, still indicating a

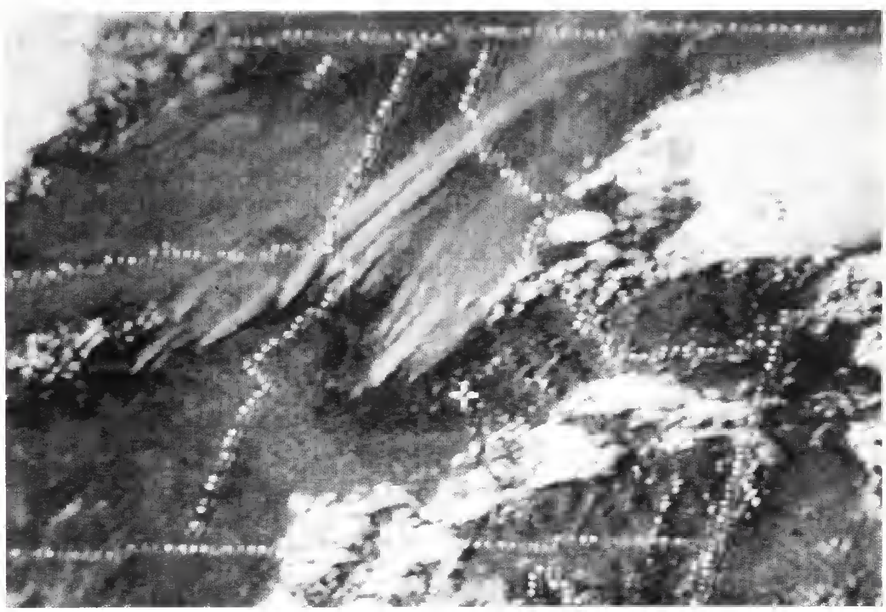

Figure 4—*Late afternoon satellite picture showing large smoke plumes from fires in central Idaho and northeast Oregon.*

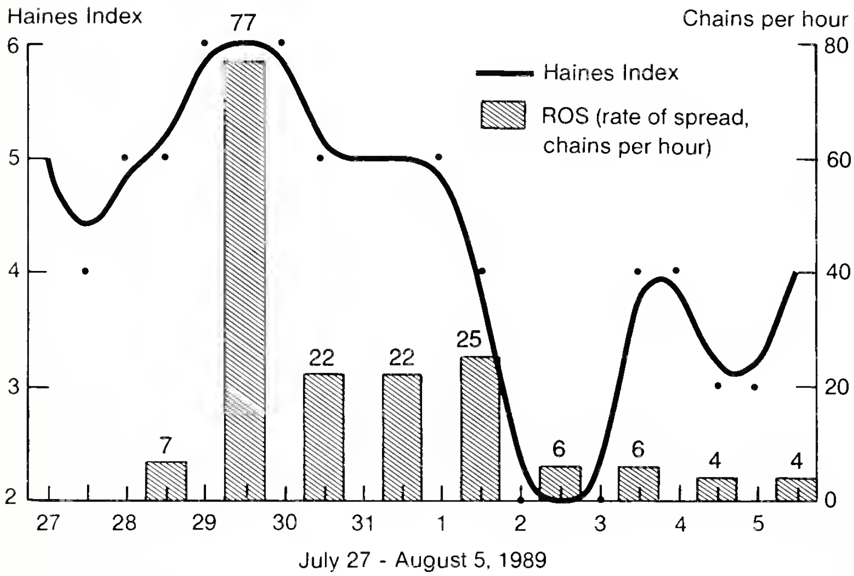

Figure 5—*Haines Index compared with rate of spread (ROS) for Lowman Fire, July 27 to August 5, 1989. Key: 6 = high, 5 = moderate, 4 = low, and 2–3 = very low.*

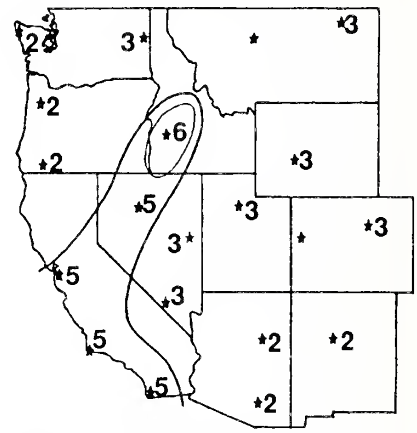

***Figure 6**—Haines Index map for 0600 MDT, July 29, 1989. Solid contour indicates a value of 5 or greater; dashed contour, 6. (The Great Falls, MT, and Grand Junction, CO, data are missing for July 19, 1989.)*

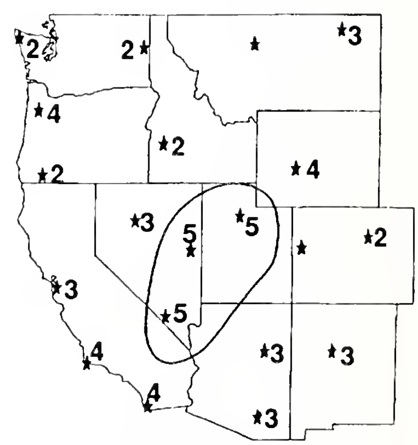

***Figure 7**—Haines Index map for 0600 MDT, August 2, 1989. Solid contour indicates a value of 5. (The Great falls, MT, and Grand Junction, CO, data are missing for August 2, 1989.)*

moderate potential for large growth. Although the ROS dropped to 25 chains (503 m) or less per hour, the fire continued to move too quickly to fight effectively. The Haines Index (fig. 7) dropped into the low-very low range August 2, resulting in a significant drop in the fire's ROS (5 chains (101 m) or less per hour).

Extreme fire behavior, with crowning and long-range spotting, was exhibited by the fire when the Haines Index was 5 or 6, but when the index lowered to 4 or less, fire activity significantly diminished.

1990 Results

During the 1990 fire season, the Boise Fire Weather Office included the Haines Index in the daily fire weather forecasts. A computer-generated map of Haines Index values across the Western United States was also produced twice a day, based upon the 0600 and 1800 MDT upper air data. The Haines Index was then compared with the acreage burned on the Boise Fire Weather District (Southern Idaho, western Wyoming, and extreme southeast Orgeon) to see if there was a correlation between days in which the index was in the high category and the occurrence of large fires. Between July and September, the Haines Index was 6 (high potential for large fire growth) on only 6 percent of the days. Over 75 percent of the burned acreage occurred on these days. The Haines Index was 2, 3, or 4 (very low or low potential) on 68 percent of the days. Only 7 percent of the acreage burned on those days. Needless to say, fire activity on the Boise Fire Weather District in 1990 verified the Haines Index.

Summary

The Haines Index, which combines values for instability and dry air, is a valuable indicator of the potential for large fire growth. Dry air affects fire

behavior by lowering fuel moisture, which results in more fuel available for the fire and by increasing the probability of spotting. Instability affects fire behavior by enhancing the vertical size of the smoke column, resulting in strong surface winds as air rushes into the fire to replace air evacuated by the smoke column. This is the mechanism by which fires create their own wind. When the Haines Index number is 5 or 6, the probability of extreme fire behavior (crowning and spotting) significantly increases. Fire behavior is usually low, with only minimal fire growth, when the index number is 4 or less. The Haines Index is best suited to plume-dominated fires; that is, fires where the power of the fire is greater than the power of the wind or the atmosphere. Wind is not a parameter of the Haines Index. The index has yet to be tested on fires driven by winds, such as Santa Ana and Sundowner where the power of the wind is greater than that of the fire. ■

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Acquisition Guidelines for FEPP

Staying within the authority and intent of the legislation authorizing the lending of Federal Excess Personal Property (FEPP) to the State Foresters to help meet the national need for rural and wildland fire protection capability and resources can sometimes be confusing. Under this legislative authority, State Foresters and their fire service cooperators have acquired trucks, tools, and other items directly related to fire suppression.

Here is some guidance for program managers on what types of items are unacceptable for acquisition as FEPP and the circumstances in which FEPP items can be used.

Unacceptable Items for FEPP Program

The following types of items cannot be acquired as FEPP in this program: Hazardous materials, recreational and athletic equipment, nonfire protective clothing, firearms, office machines, sedans, cameras, paint, cement mixer trucks, asphalt spreaders, trash compactor trucks, street sweepers, bucket trucks and cherry pickers, truck-mounted posthole diggers, and appliances (special authorization necessary).

Acceptable Items for FEPP Program Fire Suppression Activities

In addition, State Foresters can acquire for loan to fire service cooperators, including State conservation camps and inmate crews, *only* those items which are designed for, or can be modified for, *direct use in fire suppression activities*. These will normally be limited to the following: Trucks, tanks, firetools, winches, hoses, nozzles, air compressors, breathing apparatus, protective clothing, tactical communication systems, trailers, generators, vehicle parts and tires, light bars and sirens, and materials to fabricate and maintain these items. *This list does not include furniture, building materials, office supplies and equipment, or handtools.*

These lists are not comprehensive. Other items not listed here could possibly come up for decision.

Agreements in Place

Each cooperator must have an agreement in place with the State Forester that outlines the terms and conditions of the loan of property before the State Forester authorizes a specific loan and delivers the property.

Further information on the FEPP program can be obtained from the regional or Washington Office FEPP manager. ■

Francis R. Russ, *property management specialist, USDA Forest Service, Fire and Aviation Management, Washington, DC, and chairman of the FEPP Study Group*

Vegetative Management in the Wildland-Urban Interface

Dick Manning

Freelance writer, Missoula, MT

Just outside Missoula, MT, there is a well-used and well-loved canyon that bears the scar of catastrophe. Some 1,200 acres (486 ha) of snags and stumps testify that fire ran Pattee Canyon's south edge, leveling six homes in the beat of an hour.

Yet in the years since this fire in 1977, Forest Service officials have learned much about what makes such fires roar as well as some hard lessons about the volatile mixture of forests and homes. With those lessons in mind, they returned in 1990 to Pattee Canyon, this time to the unburned north side, and began a unique project to prevent a horrifying bit of déjà vu for the residents there.

Understanding the basis of the project, however, requires more than a look at the scar. The project's rationale lies at the collision point between two long-term trends that have reshaped the forests of the Northern Rocky Mountains.

Changes in Pattee Canyon

First, more people are choosing to live in the woods. Such factors as increased mobility, affluence, and leisure time have combined to cause development to creep up the slopes of canyons and hillsides adjacent to urban areas. Pattee Canyon, which empties into an urban area of about 80,000, is no exception. It is dotted with expensive homes, many of them tucked next to heavily forested tracts of Federal, State, and private timber lands.

It is the second trend, nearly a century's worth of fire suppression, that poses the greatest peril not only to those homes but also to the ecosystem of the canyon. Fire suppression has altered the nature of Western forests, rendering them, ironically, far more susceptible to destruction by castastrophic fire. We need go no further than Pattee Canyon to learn what has happened.

"They seem to have been very careful and sensitive to a lot of issues."
—Bill Farr, member of area homeowners' association

Pattee Canyon lies close to the Forest Service Intermountain Research Station and the University of Montana, both centers for the study of fire ecology. Steve Arno, a fire researcher with the Intermountain Fire Sciences Laboratory and Jim Habeck of the University's Botany Department, examined the canyon carefully. Their definitive study found that a very different ecosystem existed before the days of Smokey Bear.

Reading the living record of stumps dating back to the early 1700's, they found that until 100 years ago, the site typically hosted anywhere from 3 to 14 trees per acre, virtually all towering ponderosa pine. In 1987, the same site held from 200 to nearly 4,500 trees per acre. Further, the majority of the trees now, especially the smaller ones, were Douglas-fir.

The difference was fire. The researchers found that from 1750–1900, fire swept the area at 5- to-10-year intervals, killing the encroaching Douglas-fir and leaving the more fire-resistant ponderosa pine and western larch. Those natural fires were relatively mild because they occurred when the encroaching trees were small. "The situation is very different today," says Cathy Stewart, a former silviculturist with the Missoula Ranger District on the Lolo National Forest,[1] "because the dense undergrowth protected by fire suppression creates what is known as a 'fire ladder.' Using the fuel of the undergrowth, the fire can leap to the crowns of the ponderosa, sweeping the canyon in destruction."

Arno observed, "It was the leaping of that ladder that caused the 1977 inferno." Stewart added, "The dense stand of trees also makes the forest far more susceptible to beetle infestations and other plagues, especially mistletoe, that, in turn, kill more trees than was formerly the case and create an even greater danger of fire."

The Challenge and the Action Plan

Here was a rare occurrence, a coincidence of interests: By heeding nature's design, the health of the forest would be improved at the same time people's houses are protected from fire. The challenge then became how to best achieve the goal of returning the forest where people now lived to its natural state, a challenge the Missoula Ranger District addressed in an environmental assessment and decision reached in the summer of 1989.

In some areas, the decision would have been simple. The Forest Service is increasingly using fire to fight fire by thinning volatile forests with prescribed burns. The solution for Pattee Canyon was not that easy. "The tool

[1] Currently Stevensville Ranger District silviculturist on the Bitterroot National Forest.

was ruled out in the more visually important areas of the canyon, largely because of the residents' concerns about the appearance of a blackened forest," said Dan Bailey, zone fire manager on the Lolo National Forest who worked with homeowners. "We felt we couldn't take the criticism," Bailey said. This was a sensitivity the homeowners acknowledged and appreciated. "They (the Forest Service) seem to have been very careful and sensitive to a lot of issues," said Bill Farr of the area's homeowners' association.

Instead of relying on prescribed fire, the Forest Service will thin tree stands in the area, using horses instead of tractors to skid trees and lessen the effects of the project. Ultimately, the project will cover 210 acres (85 ha), but in the first phase, completed in 1990, only about 42 acres (17 ha) were thinned. Subsequent phases will be initiated every 5 years to soften the effects of the thinning and to allow residents to adjust to the changes. The end result will be a healthier forest, more fitted to nature's design, more parklike and open to recreation, and more hospitable to the homes people have built to find peace in the shelter of the trees.

For additional information about the project, contact: Dan W. Bailey, Zone Fire Manager, Lolo National Forest, Missoula Ranger District, Building 24a Fort Missoula, Missoula, MT 59801; telephone 406–329–3933 and FTS 585–3933. ■

Proceedings of the 1988 Interior West Fire Council Annual Meeting and Workshop

The last joint session of the Intermountain Fire Council and Rocky Mountain Fire Council was held at Jackson, WY, in October 1987. One of the major decisions made by the members of both councils at the business meeting was the consolidation of the two councils into one council to be known as the Interior West Fire Council (IWFC). The principal goal of both these organizations has been the general improvement of wildland fire management practices through participation in a central forum of member agencies. The current council members are (in alphabetical order): Alberta, Colorado, Idaho, Kansas, Montana, Nebraska, North Dakota, Northwest Territories, Saskatchewan, South Dakota, Utah, and Wyoming.

The first annual meeting and workshop of the IWFC was held October 24–27, 1988, at Kananaskis Village, AB. The theme of the 1988 meeting and workshop was "The Art and Science of Fire Management." Over 265 delegates from Canada, the United States, and Australia attended. Thirty-six invited presentations were made, preceded by a keynote address and followed by a workshop summary, in four technical sessions on the following topics:

- Fire management problems and opportunities
- Fire research programs in support of fire management decisions and solutions
- The role of new technologies, analytical systems, and support services in fire management activities
- Fire management actions and practices

The program also featured vendor-exhibitor displays, a poster session, a luncheon and banquet with distinguished speakers, and a half-day field trip to Banff National Park. The proceedings have now been published. Registered participants will automatically receive a copy. Others wishing to obtain a copy should request the Information Report NOR–X–309 (M.E. Alexander and G.F. Bisgrove, technical coordinators; 1990) from Forestry Canada, Northwest Region, Northern Forestry Centre, 5320–122 Street, Edmonton, AB, Canada, T6H 3S5. ■

Martin E. Alexander, *and* **Gordon F. Bisgrove,** *respectively, fire research officer, Forestry Canada, Northwest Region, Northern Forestry Centre, Edmonton, AB, and superintendent, Alberta Forest Service, Whitecourt Forest, Whitecourt, AB*

The Lodge at Kananaskis, Kananaskis, AB, Canada: Site of the First Interior West Fire Council Annual Meeting and Workshop, October 24–27, 1988.

A Power Backpack Pump With Foam Capability

Tom French

Warehouse foreman, Payette National Forest, McCall, ID

During the 1990 fire season, personnel on the Payette National Forest converted a power weedsprayer into a power backpack pump for fire suppression operations, using Class A wildland fire foam and an aspirating nozzle, and then tested its performance. We successfully used this backpack pump for both hotline and mop-up operations. It was especially useful for mop-up because of its efficient production of high-quality foam.

The Backpack Sprayer

We used a Maruyama Power Backpack Sprayer, Model MS-045, with these specifications:

Characteristics	*Specifications*
Dimensions (length × width × height)	14 × 16 × 23 inches (365 × 410 × 590 mm)
Weight (empty)	16.5 pounds (7.5 kg)
Chemical tank capacity	6 gallons (23 L)
Fuel tank capacity	1.6 quarts (1.5 L)
Maximum pressure	360 psi (14 kgf/cm²)
Normal output flow	1.6 quarts per minute (1.5–7 L/min)
Revolutions per minute (RPM)	6,500
Fuel	Gas:Oil mixture (25:1)
Cost	$350.00

The Aspirating Nozzle

The nozzle is made from a brass tube which is 4 inches (102 mm) long and ½ inch (12 mm) inside diameter. The tube has 6, 3/16-inch (4-mm) holes drilled ¼ inch (7 mm) from the end and is attached to the spray side of a standard Federal Supply Service (FSS) Fedco Backpack Twin Tip Nozzle. First, the small bell on the end of the spray side of the twin tip nozzle must be filed off to allow proper ratio of air to water and foam. Then, the tube is attached to the nozzle by brazing or with "silver" solder. When finished, the holes should be aligned just below the nozzle tip.

How To Use

Fill the backpack pump with 6 gallons (22.7 L) of water and add 4 ounces (113 gm) wildland fire foam—we use Monsanto WD-881 packaged in 4-ounce bottles. Screw the aspirating nozzle either on the spray handle or to the end of the wand attachment. Start the engine, and apply foam. To use a straight stream, simply unscrew the foam nozzle and screw on the straight tip, which is the other side of the Fedco Twin Tip Nozzle.

Using this power backpack pump, we were able to produce a foam line 700 feet long and 1 foot wide in 5 minutes and 12 seconds.

The quality of foam can be adjusted by adding more foam to the water and by increasing or decreasing the engine speed. A slow engine speed creates a wet foam, and a

Maruyama power backpack pump.

Aspirating nozzle.

Lynn Bleeker, Payette National Forest engine foreman, demonstrates the use of power backpack pump.

higher engine speed, a dryer foam. Using this power backpack pump, we were able to produce a foam line 700 feet (213 m) long and 1 foot (0.3 m) wide in 5 minutes and 12 seconds.

Other Applications

The power backpack pump and aspirating nozzle has other uses, besides wildland fire suppression:

- Spray for weeds and pests.
- Disinfect the inside of campground outhouses.
- Mark trees with paint for timber sales.
- Paint or stain fences, logs, houses, and decks.
- Waterseal driveways, bricks, and cement.
- Wash outside house windows.
- Keep as extinguisher in shops, warehouses, lumberyards, and boats. Use Aqueous Film Forming Foam (AFFF) 3-percent foam and the aspirated nozzle tip.
- Clean heavy equipment radiators in the field.
- Wash cars, boats, airplanes, and equipment.
- Spray nonflammable degreaser on engines, lawn mowers, chain saws, aircraft engines, tools, and equipment.
- Apply fire retardant chemical to the shake roofs of houses in the wildland-urban interface.

The nozzle tip can be used on a Fedco Trombone Backpack Pump to produce foam, using 4 ounces (113 gm) of wildland fire foam in the water.

With these applications, this sprayer can be utilized year-round and not just during fire season.

Yellowpine's Fire Survival Story

The small back country town of Yellowpine, ID, is only accessible by snowmobile in the winter months. The town has a fire engine, but in winter it is snowed in. This town fights fire with the power backpack pump carried to the fire scene on a snow machine. It is the only way Yellowpine firefighters can reach the fires.

This innovative list of the power weed sprayer and aspirating nozzle uses as described here can be further expanded. For instance, agencies, rural fire districts, farmers, and others that stock power weedsprayers can easily convert these sprayers to firefighting tools by just adding 4 ounces of wildland fire foam to 5 gallons of water and attaching an aspirating nozzle.

Recommendations

After our use and testing this year, we have recommended these modifications of the sprayer to the manufacturer: Replace the plastic tank with a flex tank; reposition the throttle linkage, and improve the backpack and strap design. These modifications should be completed by the fire season of 1991. ■

The 1988 Wildland Fire Season: Revisions to Wage, Equipment, and Training Standards

Katie Mac Millen

Editor, Montana Department of State Lands, Missoula, MT

MONTANA DEPARTMENT OF STATE LANDS

The Problem

The extreme 1988 fire season was the first time in Montana that wildland agencies called on a significant number of local government firefighting forces or equipment for help—nothing like the one or two water tenders and their crews of previous seasons. Abruptly, firefighters from all kinds of backgrounds and all parts of the country were mixed together in one location. As the firefighters talked to each other, they soon found out that vastly different rates were being paid for similar equipment and crews.

The hiring agencies had contracted engines and crews from throughout the country at disparate rates. What equipment and wage rates were depended on how quickly a firefighter crew or crew supervisor sized up the situation and bargained astutely. Just how hard people negotiated was partly based on their background, not only where they had come from, but what their employment status was—whether they were full-time, part-time, or volunteer firefighters and whether union or nonunion. Some wage variations were extreme. For instance, a California company officer was paid $600 per shift while Montana company officers were paid $5.60 per hour. Not only were rates for wages and equipment inconsistent, but the training required and the way engines were typed for a particular job varied enough to affect performance. Dissension ebbed and flowed throughout the long fire season.

How To Find a Solution

The season forced all Montana fire agencies, both hiring and serving, to look at how well—or how poorly—they had been cooperating. The result of this look was to say "never again" to the confusion they had seen in 1988. In the fall of that year, the Northern Rockies Coordinating Group (NRCG) and the Montana State Fire Chiefs Association decided at their annual postseason conference to do something about the inconsistent wage and equipment rates and matching of engine type to fire situation. They put together a nine-person task force. Eventually, 23 people joined the task force to make a 32-member interagency committee under the Fire Chiefs Association. Represented were the USDI Bureau of Indian Affairs, Bureau of Land Management, and the National Park Service; the USDA Forest Service; Idaho Department of Lands; and Montana's Department of State Lands (DSL), Fire Services Training School, State Fire Chiefs Association, State Fire Marshal Bureau, and Volunteer Firefighters Association.

The committee's goal was to create standards in three areas: minimum training, matching engine type more precisely to the fire situation, and contract rental and pay rates for apparatus and personnel. The committee developed objectives for each topic, broke up into three subcommittees to address the three issues, and spent the winter of 1988–89 developing standards.

State of Montana and Forest Service Type VI engines in Cooke City, MT.

The Three Subcommittees—Wrestling With Each Issue and Finding a Solution

Training. The training subcommittee had it fairly easy. The problem was that the National Wildland Coordinating Group (NWCG), whose standards most agencies use, had minimum training requirements for

wildland firefighters, but not for structural firefighters at wildland incidents. The subcommittee realized that the National Fire Protection Association's (NFPA) 1001 standards for structural firefighters would round out NWCG's wildland qualifications by adding wildland firefighting standards for structural firefighters at wildland incidents. They adopted the qualifications of the NFPA 1001 standards and recommended that the interagency committee ask NWCG to adopt them as well.

Engine Typing. The engine typing subcommittee had it a little tougher. NWCG's fireline handbook at the time described eight Incident Command System (ICS) engine types. (The November 1989 edition of the handbook lists seven engine types.) These descriptions of the ICS engine types included such characteristics as feet of hose and hose size, pump pressure, and water capacity; however, they did not offer the degree of distinction for each engine type that people out in the field needed to decide whether an engine could perform adequately on a job.

The NWCG standards also did not match the NFPA's 1901 (fire apparatus) or 1500 (health and safety) standards. During the 1988 fire season, this had meant firefighters might find themselves working with engines not capable of protecting or fighting structural fires because they did not have the minimum structural firefighting equipment, such as self-contained breathing apparatus. Furthermore, at the time, the NWCG described decade-old engine-typing categories based originally on California-typing. These typing divisions did not now match the types of engines that agencies in other Western States were building and using.

The interagency committee was able to find a way out of the dissension of the 1988 fire season because everyone wanted a working product.

The subcommittee standardized the engine typing in three ways. First, they considered the newer ways that engines were actually being built and used and revised the criteria by which engines were being typed to reflect that reality. The new criteria, some slightly different from NWCG's and some additional, defined three structural engine types and four wildland engine types. Secondly, they adopted NFPA 1901 standards for structural fire apparatus. The NFPA standards more specifically define the minimum apparatus and safety features required for each engine. Finally, they adopted NFPA 1500 standards for health and safety.

Rates for Equipment and Personnel. The subcommittee on wage and equipment rates had by far the toughest time resolving its difficulties. In trying to create an umbrella rate system, it had to solve the rate problems for both engines and employees, contracted or employed directly. However, disagreements about how to move toward a set of standards continued to obstruct the committee. The difference in philosophies between wildland and structural firefighters formed the basis of the disagreements.

The subcommittee decided, rather than try to change philosophical approaches to firefighting, to look at the collected data and study the range of rates then being paid for emergency equipment. At the time, the Western State Fire Managers, working on behalf of the Council of Western State Foresters, had just finished a study surveying equipment

National Guard in Yellowstone National Park.

rates in 17 Western States.[1] Using the study results, the Western State Fire Managers plotted the range of pay rates for emergency equipment by State. The subcommittee also realized that pay for Federal Excess Personal Property was too complex a topic to dictate standards for, but would have to be decided instead on a case-by-case basis.

For personnel rates, the committee started with an already existing master agreement between the Federal Government and the States of Idaho and Montana. Since most firefighters of the 1988 fire season were paid either the high Forest Service AD (Administratively Determined) rates with no overtime or the lower State rates plus overtime, the committee had to choose which of these pay systems to adopt as the norm. (Federal emergency firefighters are exempt from the Fair Labor Standards Act.[2]) The master agreement stated that cooperation with local governments was desirable. Because DSL already had well-established ties to most local government forces through its county cooperative program (49 out of 56 counties), the committee interpreted "cooperation" and "desirable" to mean sticking to what the local governments were accustomed to—essentially, close to DSL pay rates.

In the end, the DSL developed and proposed a payment matrix, usually midway in the pay-scale range of the local government rates for each ICS position on a fire and the newly defined engine types. The subcommittee agreed to the proposed rates. All the pay rates were lower than the Federal rates, but overtime pay levels out the difference between the two pay systems. In other words, the agreed-on pay rate for each position is a lower hourly wage than the Forest Service's rate but roughly equal when an overtime differential is figured in.

All agencies and fire services in the northern Rockies are now paying and getting paid the same amount for equivalent equipment, and pay rates for personnel are mostly standardized. The DSL changed its own pay rates as a result of the agreement. Because of DSL's ties to county firefighting, the agreement also designated DSL to be the main contact and center for hiring for all local government fire forces. There now is a set of guidelines detailing how to use local government forces in the most efficient manner, and the DSL should soon have complete availability lists, pulled together from data from all affected counties. This organizational system, the guidelines, and lists will help in hiring and sending the geographically closest force with the right equipment and personnel—standard and suitable—to fires throughout Montana.

Where We Stand Now

The subcommittees made their recommendations to the larger committee, which reviewed and voted on them. On all levels, it took a great deal of movement and compromise to come up with the end product. The process resulted in the 10 agencies present agreeing to use the methods of training, engine typing, hiring, and payment described here.

After the committee agreed to the new set of standards, it passed them on to the NRCG to implement. The NRCG in turn christened two groups of its own to look into the matter: the rate group and the equipment group. The two groups in the NRCG reviewed and then agreed to implement the typing and rate changes and issued them as the Interagency Fire Business Management Handbook. All 10 agencies in the agreement can now use the handbook.

For the 1989 fire season, the committee put out a draft set of these standards part way through the season, and the field tested them for the better part of the season. During the winter of 1989–90, the committee fine-tuned the typing standards again. This standardization is an ongoing process—NRCG maintains its two groups, so representatives from the original agencies can review standards yearly. Any time these standards do not work, NRCG can change them—they are not etched in granite. The main goal has been reached: There are agreed-on standards throughout the northern Rockies.

The interagency committee was able to find a way out of the dissension of the 1988 fire season because everyone wanted a working product. There had been too much variation in areas important to fighting fire effectively. The standards, an impressive accomplishment, were built with determined cooperation between the using and the sending agencies. ■

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[1] Alaska, Arizona, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Washington, Wyoming, and Utah.

[2] 5 U.S.C. §5102(C)(19), 7 U.S.C. §2225-6, 43 U.S.C. §1469.

A Laser-Based Forest Fire Detection System

J.P. Greene

Fire resource manager, Florida Division of Forestry, Fire Control Bureau, Tallahassee, FL

In the Southeastern United States, humans start more than 90 percent of wildland fires. Detection as well as prevention and suppression has long been one of the priority efforts in a successful fire management program. Automated lightning detection systems have greatly improved the detection of naturally occurring fires, but we still detect human-caused fires in much the same way we have since the initiation of fire protection in the United States—by human observation from either a lookout tower or, in recent years, from aircraft.

The Florida Division of Forestry depends on lookouts in some 180 towers, supplemented by aircraft patrols, to spot smokes over the 25 million acres (10.1 million ha) of forest and wildlands in the State. Staffing and maintaining the lookout system entails an expenditure of more than $2 million per year. The division, in seeking more efficient and economical methods of fire detection, is exploring new technologies associated with the detection of forest fires.

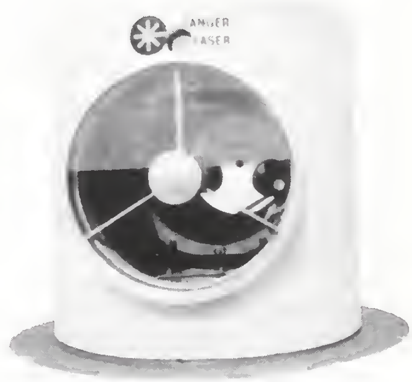
New Detection Technology

A French team of engineers is well along toward the development of such a technology—laser-based forest fire detection. The Blommé Automation Départment de la Société Nouvelle Jules Verger-Delporte, located in Maisons-Laffitte near Paris, is a firm primarily oriented toward the development and production of electronic and computer control systems and machinery for the manufacture of semiconductors. In recent years, it has taken an active role in the development of new forest fire detection technology, including the laser system.

The laser system prototype is currently installed at Labouheyre, near Bordeaux, in southwestern France. This is a flat, coastal region with extensive plantations of the French maritime pine (*Pinus pinaster*), which makes it very much like the timbered areas of the southeastern U.S. coastal plain. Many of the 121-foot (37-meter) concrete water towers in the area house fire lookouts. The prototype laser system is installed in such a tower.

When the laser beam strikes an obstruction, whether solid as a tower or insubstantial as a smoke column, energy is returned to the transmitter, which determines the direction of the target and computes its range.

The system consists of a pulsed, infrared laser projected through a rotating optical system that aims the beam 2 minutes above the horizon. When the beam strikes an obstruction, whether solid as a tower or insubstantial as a smoke column, energy is returned to the transmitter, which determines the direction of the target and computes its range. The data is transmitted to a central control facility (in this instance at Mont de Marsan, about 25 mi or 40 km away) via telephone or radio, and the location of the return is plotted on a computer map. The unit is programmed to ignore "authorized" returns, such as radio towers and factory smoke.



Detector head for Blommé laser-based detection system.

The current prototype unit, in operation since June 1990, is approximately 9 feet (2.8 m) high and weighs about 500 pounds (227 kg). Production models would be somewhat smaller and lighter.

During a recent demonstration at Labouheyre, three test fires of straw were lit. The first was detected at a range of 5 miles (7.5 km) approximately 5 minutes before it was visible to an observer in the tower. The second was detected and displayed at the control center at the same range. The third was not detected at a range of 9 miles (15 km) due to wind dispersion of the rather scant smoke column. Factory smoke has been detected at a range of 16 miles (25 km), but the reliable limit of the system is considered to be about 12 miles (20 km) due to the curvature of the earth.

Strengths and Limitations

The prototype of the laser detection system works convincingly. It reliably detects fires at a considerable

range while the fires are still small in size. Its performance should be expected to equal or exceed that of a human observer under most conditions. Particular strengths of the system include 24-hour automatic detection, very sensitive detection, automatic alarms and controls, central reporting and control by one operator for several detectors, software adaptable to any land survey system, accurate fire location with one-way sightings, and the ability to see two smokes in the same direction at different distances.

The system is limited by its inability to discriminate between smoke columns and isolated rain showers, blinding by the rising and setting sun for about half an hour over a 5 degree arc, and range reduction by rain and fog.

Current Status

The permitting process in the United States has yet to be formally undertaken, but Blommé personnel feel that approval can be obtained for this use because the laser beam is optically dispersed and the energy is not concentrated in one spot for an extended period. In addition, the apparatus has safety interlocks which automatically shut down the laser in case of malfunction.

Industrial development of the system has just begun, so costs in the United States have not been determined. However, the system appears to offer a viable alternative for the detection of forest fires in some areas of the United States and is expected to be available soon. ■

National Advanced Resource Technology Center Course Schedule for Fiscal Year 1992

The USDA Forest Service, National Advanced Resource Technology Center (NARTC), Marana, AZ, provides national-level training courses to wildland management agencies here and abroad. The Forest Service selects courses based on suggestions from other participating natural resource agencies, including the National Wildfire Coordinating Group. Students are nominated to attend by their own agencies.

For detailed information, the course schedule, and nomination forms, contact the Director, NARTC, Pinal Air Park, Marana, AZ 85653. FTS 762-6414; commercial (602) 629-6414; DG—NARTC: W06A; FAX 762-6413.

Date	Course
December 1–6, 1991	Senior Level Aviation Management Course
January 6–10, 1992	National Fire-Danger Rating System Applications Course
January 13–17, 1992	National Fire-Danger Rating System Operations Course
February 2–7, 1992	National Parks and Wilderness Fire Management Course
March 1–6, 1992	National Fire Management Analysis System Technician Course
March 9–13, 1992	National Fire Management Analysis System Manager Course
March 30–April 9, 1992	Fire in Resource Management Course
April 13–17, 1992	Watershed Emergency Burn Team Leaders and Seeding Managers Course

Computer Calculation of the Keetch-Byram Drought Index—Programmers Beware!

Martin E. Alexander[1]

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The Keetch-Byram Drought Index or KBDI (Keetch and Byram 1968) has been or is still being used as a guide for estimating the cumulative moisture deficiency in deep duff or upper soil layers. Such information is needed for planning fire management operations in many regions of the world (McArthur 1966, 1967; Cheney 1971; Mount 1972; Valentine 1972; Wade and Ward 1973; Burgan, Fujioka, and Hirata 1974; Just 1978; Noble, Bary, and Gill 1980; Crane 1982; Sirakoff 1985; Swart 1986; Burgan 1988; Melton 1989; Donaldson and Paul 1990; Jordan 1990). As well, the KBDI has been widely utilized in various fire research studies (Burgan 1976; Haines, Johnson, and Main 1976; Dayananda 1977; Miller 1978; Olson 1980; Lorimer and Gough 1982, 1988; Hall and Gwalema 1985; Johansen 1985; Van Wagner 1985; Burrows 1987; Gill, Christian, Moore, and Forrester 1987; Brown, Booth, and Simmerman 1989).

It has come to my attention (Crane 1983) again that there are two significant typographical errors in the original 1968-published USDA Forest Service Research Paper SE–38 dealing with the drought index developed by John J. Keetch and George M. Byram. Crane (1982) determined that the equation used to calculate the daily drought factor was in fact incorrect. The last constant in the numerator of Equation 18 on page 31 of Keetch and Byram's (1968) publication should have been 8.30 and not 0.830 (fig. 1). The end result of this error is a drought factor that is always slightly higher than the correct value (table 1). Crane (1982) also suggested that the last constant in the numerator of Equation 15 on the same page should have been 0.213 instead of 2.113. However, in a review draft of Keetch and Byram (1968) dated October 22, 1966, which was kindly provided by D.R. Packham (Commonwealth of Australia, Bureau of Meteorology, Melbourne, Victoria), it's clear that the errors in Equations 15 and 18 were both typographical in nature, and the constant in the former should have been 0.2113. It's worth noting that the drought factor tables contained in Keetch and Byram's (1968) report, which are based on Equation 18, are correct however.

... there are two significant typographical errors in USDA Forest Service Research Paper SE–38 dealing with the drought index developed by John J. Keetch and George M. Byram ... the misprints in Equations 15 and 18 have been corrected in a 1988-revised reprinting of the publication ....

Just how insignificant are these sources of error in calculating the KBDI? On a day-to-day basis, the error may have only a small effect on the resultant value (table 1). However, a computer-calculated value would eventually depart considerably from the correct value due to the cumulative nature of the KBDI, especially during a rainless period (Fujioka 1991). There will of course always be differences between equation-calculated values and those derived from tables when it comes to fire danger indices (Deeming 1975).

English unit equation [corrected] from Keetch and Byram (1968)

$$dQ = \frac{[800 - Q]\,[0.968 \exp(0.0486T) - 8.30]\, d\tau}{1 + 10.88 \exp(-0.0441R)} \times 10^{-3}$$

S.I. unit equation from Crane (1982)

$$dQ = \frac{[203.2 - Q]\,[0.968 \exp(0.0875T + 1.5552) - 8.30]\, d\tau}{1 + 10.88 \exp(-0.001736R)} \times 10^{-3}$$

Symbol	Quantity	English units	S.I. units
dQ	Drought factor	0.01 in	mm
Q	Moisture deficiency[1]	0.01 in	mm
T	Daily maximum temperature	°F	°C
R	Mean annual precipitation	in	mm
dτ	Time increment	= 1 day	= 1 day

[1] Yesterday's KBDI or value as reduced by the daily net precipitation (i.e., the amount in excess of 0.20 in or 5.1 mm).

Figure 1—*The two versions of the equation used to calculate the daily drought factor in computing the Keetch-Byram Drought Index (KBDI).*

[1] The author, a fire research officer with the Northwest Region of Forestry Canada stationed at the Northern Forestry Centre in Edmonton, AB, is presently on professional development and educational leave in Australia.

Table 1—*Increase in the value of the daily drought factor of the Keetch-Byram Drought Index (KBDI) as a result of the typographical error in Equation 18 of Keetch and Byram (1968). Please note that due to the nature of the error in Equation 18, the increase above the actual value is independent of daily maximum temperature.*

Mean annual precipitation		Yesterday's KBDI[1] or value as reduced by the daily net precipitation							
(in)	(mm)	100	200	300	400	500	600	700	800
10	254	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
20	508	1.0	0.8	0.7	0.5	0.4	0.3	0.1	0
30	762	1.3	1.1	1.0	0.8	0.6	0.4	0.2	0
40	1,016	1.8	1.6	1.3	1.0	0.8	0.5	0.3	0
50	1,270	2.4	2.0	1.7	1.4	1.0	0.7	0.3	0
60	1,524	3.0	2.5	2.1	1.7	1.3	0.8	0.4	0
70	1,778	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0
80	2,032	4.0	3.4	2.8	2.3	1.7	1.1	0.6	0

[1] In the original formulation of the KBDI, 800 represented the maximum possible value. However, the metric or S.I. unit scale of the KBDI technically limits the value to 203.

To my knowledge, an errata to Keetch and Byram (1968), which highlights the aforementioned problems, has never been issued. However, the misprints in Equations 15 and 18 have been corrected in a 1988-revised reprinting of the original publication, although no mention of these corrections is made. This note has been prepared to alert those, who may be calculating the KBDI by computer, to these two errors, since it's not always readily apparent whether they have been detected by other users. The corrected version of Equation 18 and the one rederived by Crane (1982) in terms of the International System (S.I.) of units are presented here (fig. 1) in the interest of completeness. Furthermore, the references compiled here constitute a selected bibliography on the KBDI. ■

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The 1992 National Wildland Fire Training Conference

Performance Training
Technology
Visions of Tomorrow

The conference sponsored by the National Wildfire Coordinating Group's Training Working Team every other year is scheduled to be held in 1992 in Orlando, FL, on February 20–22, at the Clarion Plaza Hotel Convention Center on International Drive.

The theme of the training conference is "Training, Performance, Technology—Visions of Tomorrow." Many varied training sessions, with speakers and workshops, will highlight this theme. An important topic for all of us will be the new fire suppression curriculum and its development.

Plan now to attend this important conference, and be sure to budget funds in the next fiscal year. For further information, contact Jim Whitson, Florida Division of Forestry, 3125 Conner Boulevard, Tallahassee, FL 32399–1650; telephone 904–488–6111. ■

FCFAST: Fort Collins Fire Access Software

Larry S. Bradshaw and Patricia L. Andrews

Research meteorologist, Systems for Environmental Management, Missoula, MT, and team leader, USDA Forest Service, Intermountain Research Station, Missoula, MT

For at least a decade, fire managers have recognized how much the computer can accomplish in helping them to plan. No one would dispute, however, that computer use can be complicated and time-consuming—especially when a manager doesn't use a particular software package very often. The Fort Collins Fire Access Software (FCFAST)[1] is a utility designed to assist the casual user of the USDA Fort Collins Computer Center (FCCC) in accessing two databases and one software package often used in fire management planning. It removes the burden of remembering (or learning) FCCC syntax and using a text editor to put values in appropriate columns on ordered records for every application.

The databases FCFAST accesses are:

- NFWDL—The National Fire Weather Data Library (Furman and Brink 1975)
- NFODL—The National Fire Occurrence Data Library (Yancik and Roussopoulos 1982)

FCFAST does not perform analysis on datasets from a library—it extracts and optionally downloads them to a remote site where a fire manager can access the information.

The other function of FCFAST is to generate FIREFAMILY (FIRDAT, SEASON, and FIRINF) runs at FCCC, and optionally, create "passing files" when the fire manager needs them. FCFAST will generate either 1978 (Main, Straub, and Paananen 1982) or 1988 (Main, Paananen, and Burgan 1990) runs of FIREFAMILY. In the same way that datasets are extracted from a library, FIREFAMILY's passing files may be downloaded to the fire manager's local computer.

Program Structure

FCFAST is menu-driven and uses data-entry screens to solicit required information, which is checked for validity. There is also on-line context sensitive help. The on-line help is not intended to replace the user's guides for the systems that FCFAST accesses—a basic knowledge of the required information is expected. However, from the on-line help, the input prompt for each input field, and error messages on invalid entries, users can quickly construct error-free runstreams for transmission to FCCC.

Implementation

There are two versions of FCFAST. One is for use on the Forest Service's Data General computers. The other is a personal computer (PC) version. FCFAST was written using the Forest Service Application Toolkit (FSAT-Screen Utilities Library) to achieve a CEO-like format (menus, data entry screens, and function keys).[2] The PC version uses PCFSAT (Aviation and Fire Management, Pacific Northwest Research Station, Seattle, WA) to achieve a similar interface.

FCFAST removes the burden of remembering (or learning) FCCC syntax and using a text editor to put values in appropriate columns on ordered records for every application.

Forest Service Data General Systems. On the Forest Service's Data General system, FCFAST is a CEO-integrated program located at the staff level of the Information Systems (IS) area. It automatically submits runstreams to FCCC. Users are notified by IS when jobs are sent to and received from FCCC.

Personal Computers. The PC version creates runstreams for transmission to FCCC over a telephone modem. Completed runs are "captured" on the PC. If an NFWDL data file was downloaded, the captured file may be processed for analysis by PC-based software such as PCFIRDAT (Blanchard 1989). The PC version requires no specific communication package—only that the software be able to transmit a PC file to a remote computer and log screen activity to a PC file.

Program Availability

FCFAST (both DG and PC versions) is available to Forest Service users through the USDA Forest Service, Software Reference Center (SRC). SRC is accessed via the INFO_CENTER user application from the CEO interrupt menu.

The PC version of FCFAST can also be obtained from the following source: Forestry Resources Systems Institute, 122 Helton Court, Flor-

[1] This work was supported in part by funds provided by the USDA Forest Service, Intermountain Research Station (Agreement No. INT-88343-COA).

[2] CEO stands for Comprehensive Electronic Office software, the Data General Corporation program used throughout the Forest Service.

ence, AL 35630; telephone 205–767–0250.

Support

FCFAST is supported by the Forest Service, Washington Office, Fire and Aviation Management; telephone (406) 329–4950, FTS 584–4950. ■

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FIREFAMILY Returns, Revised

The USDA Forest Service's North Central Forest Experiment Station recently published FIREFAMILY 1988, a revision of the 1982 user's guide to fire planning with historical weather data. Authors of the new FIREFAMILY version are William A. Main, Donna M. Paananen, and Robert E. Burgan.

FIREFAMILY 1988 reflects changes resulting from the 1988 revisions of the National Fire-Danger Rating System (NFDRS). Improvements include:

- Increased drought response
- More flexibility to reflect the moisture content of live fuels
- Better estimates of fire danger in the autumn
- Better estimates of fire danger following rain
- A new set of 20 fuel models to implement the changes

The FIREFAMILY program has three routines: FIRDAT, which uses daily weather data to compute fuel moistures, components, and indexes of NFDRS; SEASON, which reveals patterns of fire weather severity over many years; and FIRINF, which can analyze combinations of two variables such as the burning index and the ignition component.

Each of these routines is thoroughly discussed in FIREFAMILY 1988 with an emphasis on how the user can put the various products to work. For example, the guide includes 14 illustrations of the kinds of computer output FIREFAMILY will generate. It also provides blank lead cards that can be photocopied, filled in, and given to a computer specialist for processing. Those who have access to FCFAST will find that it is a quick and easy method to generate runstreams needed for FIREFAMILY.

Appendix IV, which is completely new, describes how FIRDAT addresses the four combinations of 1978 and 1988 fuel model sets and styles of weather data. Fire managers may choose any of these combinations. For instance, if users decide to run a 1988 fuel model set with the 1988 style of weather data, they will discover that the program will modify the 1-hour, 10-hour, 100-hour, and 1000-hour fuel loads to account for changes in fuel availability due to deep drying or wetting of litter and duff.

You can order your copy of FIREFAMILY 1988 from the North Central Station Distribution Center, One Gifford Pinchot Dr., Madison, WI 53705-2398; telephone (608) 384-5237. If you have any questions about FIREFAMILY, contact Bill Main in East Lansing, MI at (517) 355-7740. ■

Donna M. Paananen, *technical writer, North Central Forest Experiment Station, East Lansing, MI*

Hurricane Hugo and the CL–215

George Brooks and Fred Fuchs

USDA Forest Service, Fire and Aviation Management, respectively, wildland-urban interface manager, Region 8, Atlanta, GA, and assistant director, Washington, DC

September 22, 1989, will be long remembered in the States of North and South Carolina. Hurricane Hugo came ashore leaving in its path massive destruction to property and forest resources. These States had little time to contemplate the destruction at hand: the specter of another disaster loomed on the horizon—wildfire.

The force of Hugo had decimated the standing timber resources. What remained, was a "jackstrawed" woodland situation sure to impede accessibility and suppression strategies normally employed within the States.

State and Federal agencies moved quickly to avert disaster. Their actions included assessments of the extent of damage and analysis to determine the needed level of fire protection. Basic fire suppression efforts within the Hugo impact area traditionally centered around the tractor plow unit operating in light litter with an absence of the larger 1000-hour fuels. The situation following Hugo would require a break from tradition for suitable fire protection and suppression capability to have some measure of success.

The CL–215 enabled a quick response to most fires—some threatening structures in places where "jackstrawed" timber and wet ground limited tractor plow access.

One aspect of the States' readiness plans included the lease of three Canadair CL–215's from the Canadian province of Quebec. These twin-engine, amphibious air tankers have water-scooping and foam-mixing capability. It was thought they would give early strike capability in areas with limited access and protection for the 1 million people and their homes within the Hugo area.

Canadair's CL—215 unloads foam on extremely hot fire spot. Photograph: Courtesy of Photographic Services Canadair.

South Carolina's Sumter County: Conditions and Suppression Response Analyzed

The State of South Carolina identified two counties best representing Hugo damage: Sumter County with light-to-moderate damage overall but pockets of heavy damage caused by tornadoes imbedded in the hurricane and Berkeley County with heavy damage. The effects of Hurricane Hugo in Berkeley County were rated equal to those identified for the Francis Marion National Forest in South Carolina.

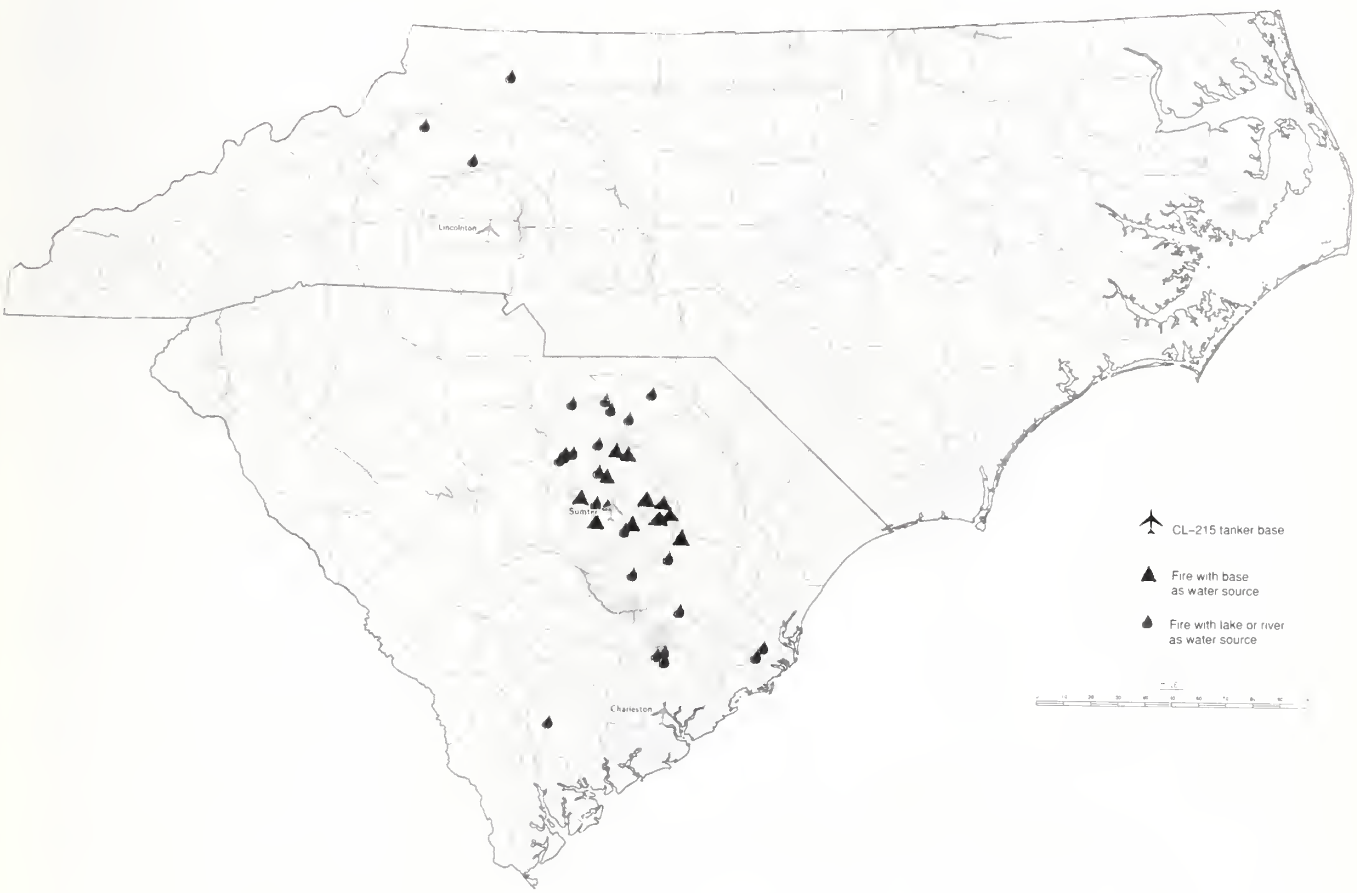
At the request of the State of South Carolina, the conditions in Sumter County were recreated in fire management computer models. Suppression action using various combinations of CL–215 airtankers, medium helicopters, and tractor plows were then applied in the model of conditions in the county. Important to this analysis are the following assumptions:

- The CL–215 airtanker could respond to a fire within 25 minutes. This would include 8 minutes departure time, 15 minutes flight time, and 2 minutes for sizing up the fire conditions and disbursement of the first load.

- Additional CL–215 drops could occur every 15 minutes with reloading from designated water sources.
- Lakes suitable for CL–215 operations are located within 15 miles of the representative fires. CL–215 airtankers can also operate and refill from the ocean offshore from Berkeley and Charleston Counties.

Review of CL–215 Operation in North and South Carolina

The USDA Forest Service is directly responsible for the protection of approximately 191 million acres (77.3 million ha) of National Forest System lands and as a partner in cooperation with the 50 States protecting 805 million acres (325.8 ha). It is in this spirit of cooperation that the Forest Service, along with the States of North and South Carolina, elected to review, after the 1990 fire season, the suitability of the Canadair CL–215 air tanker as a resource for suppression activities within the Hugo-damaged area. This was an empirical review, relying heavily on the observations of field suppression



CL–215 tanker base map. (Notes: Water available for helicopters within 1 mile (1.6 km) of all fires. Scoop mode used on 26 fires (60%). Tanker base used as water source on 15 fires (40%). Average distance of suitable water source: CL–215—17 miles (27 km); helicopter—1 mile (1.6 km).)

forces and their opinions about the usefulness and practicality of the Canadair CL–215 in meeting their needs.

Review of Data

The normally more severe winter and spring fire season failed to materialize. The above-average rainfall served to lessen the immediate threat of wildfire during the period of time the CL–215's were assigned to locations in North and South Carolina. However, comments from State fire suppression agencies indicated that the above-average, cyclical rainfall served to increase the use of the CL–215's and to decrease that of the tractor plow units with their access limitations. See table 1 for data on CL–215 use.

Discussion

The States of North and South Carolina are satisfied that the CL–215 airtankers met the intended objectives. They provided a quick response to fires located in areas of extreme fuel loading, limited access, and wet ground conditions. Preliminary analysis assumed water refill capability within 15 miles (24 km) of the fire. In actuality, this distance averaged 17 miles (27 km), closely approximating the initial assumption.

Previous studies of the CL–215 have all concluded that the cost-effective operation of the air tanker is predicated on the close proximity of suitable water sources to utilize the scooping mode. Without the water-scooping design feature, the CL–215 becomes an expensive fixed-wing air tanker. This raises an important question on the positioning of the tankers. Average distance to the fires in North and South Carolina from the airtanker base averaged 24 miles (39 km). This appears to be satisfactory, based again on the initial assumptions of the analysis. Of some concern, recognizing the limited number of fires, is the rather high percentage of refill operations at the tanker base in lieu of scooping. For 40 percent or 16 of the fires, the tankers returned to the fixed base for refill. Only 60 percent of the fires had suitable water sources nearby to allow the scooping mode to be employed and ensure shorter turnaround times.

Table 1—*Summary data for fires utilizing CL–215 air tankers*

Item	Data
Number of fires	41
Average size of fire at first drop (acres)	18 (7 ha)
Average distance	
Tanker base to fire (miles)	24 (39 km)
Helibase to fire (miles)	15 (24 km)
Tanker water source to fire (miles)	17 (27 km)
Heli water source to fire (miles)	1 (1.6 km)
Performance data	
Number of drops	224
Total gallons dropped	260,580 (986,374 L)
Gallons per hour	4,234 (16,026 L)
Flight hours	61.54
Cost data	
Flight time	$113,849.00
Cost per gallon	2.83
Standby	625,477.00
Total	739,326.00
Observed results (average)	
Fire size at first drop (acres)	18 (7 ha)
Fire size at end (acres)	30 (12 ha)
Size of acreage saved (acres)	85 (35 ha)
Total value saved per fire	$91,000.00

By comparison, water sources suitable for helicopter bucket or tank refill were located for all fires within 1 mile (1.6 km) or less of the fire. In addition, helibases averaged 15 miles (24 km) to the fire compared with the 24 miles (39 km) for the CL–215's. Previous evaluations by the USDA Forest Service have concluded that for the shorter distances between the fire and scoop site (15 mi or 24 km) helicopters with equivalent water or retardant capacity tend to be more effective than the CL–215. Basically, this is due, as would be expected, to the shorter pick-up times and therefore shorter cycle times within the range of distances. At ranges above 15 miles (24 km), the study concluded that due to the faster cruise speed of the CL–215, it begins to overcome the scooping-time increment, resulting in lower cycle times for the CL–215 compared with the helicopter.

The evaluation also determined that light-to-medium helicopters working in threes could not contain fires where the forward rate of spread exceeded 10 feet (3.1 m) per minute. However, larger helicopters with retardant capacity equal to or greater than that of the CL–215 were able to contain the fire. It is interesting to note that 25 out of 41 fires were described as running or exceeding the 10-feet (3-m) per minute rate of spread.

However, when considering helicopters as an alternative, the element of cost may be a limiting factor. The Boeing 107 with a capacity of 1,000

gallons (3,785 L) of retardant costs approximately $3,000 per hour and may not, unless operating from a portable water source in most areas, deliver a significant additional increment of retardant. In addition, the use of helicopters does present other factors which need to be considered that make any direct gallon-for-gallon or cost-for-cost comparisons relative at best.

A discussion of this review would not be complete without considering the values at risk. Life and property were the primary concern of the State agencies. The review reveals CL–215 costs seem high by traditional standards ($18,032 per fire). The estimated value of property and resources saved or protected, however, totaled $3.7 million or an average of $91,000 per fire. This is equal to a benefit cost ratio of 5 to 1. It would appear that this is significant and justifies using the CL–215's.

Conclusion

Based on the data collected, subsequent review, and comments from suppression forces in North and South Carolina, it appears that the CL–215's provided a significant fire suppression resource. The CL–215 enabled a quick response to most fires. Even in areas where heavy downed timber and wet ground limited tractor access, fires were contained that were in many instances threatening structures. Thus, the primary objectives of protection of life and property were realized through employment of the Canadair CL–215's. ■

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The Florence Fire: Lesson in Incident Command Cooperation

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A more rugged, inaccessible, and remote location to suppress a wildland fire probably does not exist anywhere in the Western United States. Sheer canyon walls and vertical rock outcrops with well over 100 percent slopes typify the Florence Creek drainage located in the Hill Creek Extension of the Uintah and Ouray Indian Reservation of northeastern Utah. The Florence Creek area is well known locally for its valuable desert bighorn sheep habitat and its populations of elk and mule deer. Some buffalo are in the general vicinity. The summer of 1990 was the fourth consecutive year of drought in northeastern Utah, so fire hazard was extremely high in July and August.

Florence Creek was the scene of a summer lightning storm on July 31, 1990. As a result, seven separate fires were ignited. These fires began burning in a variety of vegetation including Douglas-fir, ponderosa pine, aspen, Gambel oak, pinyon pine, mountain mahogany, bitter brush, sagebrush, and grasses.

This is the story of how State and Federal agencies and the Ute Indian Tribe worked together fighting that fire. It is probably one of the best examples of cooperation in a fire emergency since the inception of the Incident Command System.

The Situation and the Strategy

Six of the fires were extinguished by the U.S. Department of the Interior (USDI) Bureau of Indian Affairs (BIA) and Uintah and Ouray Interagency Crews on the first day, but the fire in Florence Creek was an entirely different matter. The terrain was so dissected, steep, and rough it was not possible to reach many parts of the main fire. During the afternoon of August 1 as winds increased, the Florence Creek Fire blew up. By nightfall, the fire size had grown to 2,500 acres (1,012 ha).

A call was made for a Class II Incident Command Team. Ed Storey from the Utah Division of State Lands and Forestry responded. His team arrived at Fort Duchesne, UT, and were briefed by the BIA on the fire's progress. Initial strategy was to contain, rather than directly attack the fire, because of the difficult terrain in the fire vicinity.

How State and Federal agencies and the Ute Indian Tribe worked together on the Florence Fire is probably one of the best examples of cooperation in a fire emergency since the inception of the Incident Command System.

Cooperative Action

Personnel. Early on August 2, fireline construction by dozers and handcrews was underway in the relatively flat plateau country bordering the canyons of Florence Creek. By that evening, 261 personnel from the Uintah and Ouray Indian Reservation, USDI BIA and Bureau of Land Management (BLM), U.S. Department of Agriculture (USDA) Forest Service, Utah Division of State Lands and Forestry, and Interagency Crews were on the fire. In the following days, firefighters and support personnel from the USDI National Park Service, Department of Commerce National Weather Service (NWS), and Utah National Guard joined the fray.

Communication. Fire suppression continued for the next 9 days before the fire was declared contained on August 11. Because of the remote location, communication with support dispatch at the Vernal Fire Center was impossible on the first day.

Necessary communication equipment had already been committed by the Interagency Fire Control Center in Boise, ID, but it had not arrived. However, BLM communication leader Bart Lewis of BLM's Vernal District and Forest Service communications technician Everett Lemons of the Ashley National Forest came to the rescue. Bart and Everett, ham radio buffs, set up a direct computer communication link via "packet radio" from the Incident Command Base Communications Unit through the Blue Mountain node "Dina" to a bulletin board system at the Vernal Fire Center. This system provided ongoing communication daily through the duration of the fire. In addition to communications tied to a system support dispatch, they also established a radio-telephone interconnect, giving to fire personnel essentially the same access as a telephone line, which includes direct long distance calls from the incident base.

Another communication system proved extremely valuable in getting the upper hand on this very stubborn and dangerous fire. A satellite dish, part of a mobile weather unit, received weather information directly from Washington, DC, which was interpreted for the Incident Command Team by Brenda Graham of the

NWS. Hourly weather reports and forecasts proved extremely valuable as the team developed strategies to put out this fire.

Helicopter Use and Safety. A firefighting tactic that was critical to the success of the team's effort was the use of helitack crews that rappelled from hovering helicopters, sometimes as much as 250 feet (76 m) on ropes to reach inaccessible areas to construct helispots. Only in this way was it possible to bring in fire crews to reach parts of the fire. The utilization of these highly skilled crews to do this critical task enabled the fire team to implement a direct attack down in the canyons to prevent the fire from hooking under control lines constructed on the ridges above. This technique enabled the fire team to implement the direct attack strategy in the canyons after it became safe to do so. The final fire size in this valuable wildfire habitat was 5,700 acres (2,307 ha), about 30 percent of what it would have been without this fire suppression effort.

Alex Stone, helicopter manager and rappel foreman, reported 15 operational rappels achieved with the construction of 11 helispots and the suppression of one spotfire outside the control lines between August 3 and 9.

Helicopter safety increased significantly on the Florence Fire. A Bell 204–B helicopter flown by pilot Steve Lotspeich of Crane Helicopter Services, Alamo, CA, used twin "Whelen Micro-Max Beam" sealed lamps mounted on the forward mirror frame. These 100,000 candle-foot lamps, which project a flashing or steady light beam straight ahead similar to a flashlight, helped pilots recognize other aircraft and avoid collision. The lamp and bracket system Steve designed can be installed anywhere on any model helicopter at a cost of $150.00. Earlier in the summer, he designed and installed the lamps and bracket on an ASTAR Helicopter. Bill McMillan, helicopter program manager for the Southern Region (Region 8), says these lights have significantly added to safety, especially when flying in heavy smoke and intends to recommend the optional use of the Whelen Micro-Max Beam light system on contract aircraft specifications for helicopter operations.

Bell 204–B with mounted Whelen Micro-Max Beam lights.

Containment and Control

Sunday, August 12, the Florence Creek Fire was declared contained and controlled, and Ed Storey's team turned the fire over to the BIA and Uintah and Ouray Indian Tribes. Their task was to begin rehabilitation of the soils and slopes exposed to rain and wind by the fire.

The outstanding cooperation of all the personnel that worked so closely together to reach a common goal was achieved primarily by the total dedication and years of practice by the men and women of Ed Storey's team working together as an Incident Command team. ■

Fire Behavior Service Center for Extreme Wildfire Activity

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Introduction

Fire management organizations often respond to severe wildfire situations without a comprehensive system for tracking fire behavior potential throughout a region. If such a system was in place, however, it would serve as a basis for establishing preparedness and suppression priorities. Recognizing the practical value of such information, the Forest Service's Northern Region in the mid-1980's implemented a fire behavior intelligence program that linked regional polygons of similar fuels and weather conditions through a regionwide center known as the Fire Behavior Service Center. The polygons, as developed by Robert Burgan at Fire Behavior Project, Intermountain Fire Sciences Laboratory (Burgan and Hartford 1988), augment the display of the National Fire Danger Rating System information for specified geographical areas. The Fire Behavior Service Center is activated and staffed during critical multiple fire situations to improve fire safety and fire suppression decisions.

This fire behavior intelligence program has provided essential information and data to line officers, fire management personnel, and overhead teams in a timely manner. We will describe the program with enough detail so that it can be used in other regions.

Organization

During periods of extreme or extensive wildfire activity, the USDA Forest Service's Northern Region's (Region 1) regional fire coordinator in Missoula, MT, is responsible for expanding the fire suppression organization to meet the needs for increased fire planning, priority setting, and safety.

The expanded fire suppression organization, referred to as the Regional Incident Coordinating Organization (RICO) (figs. 1 and 2), has designated positions, which can be

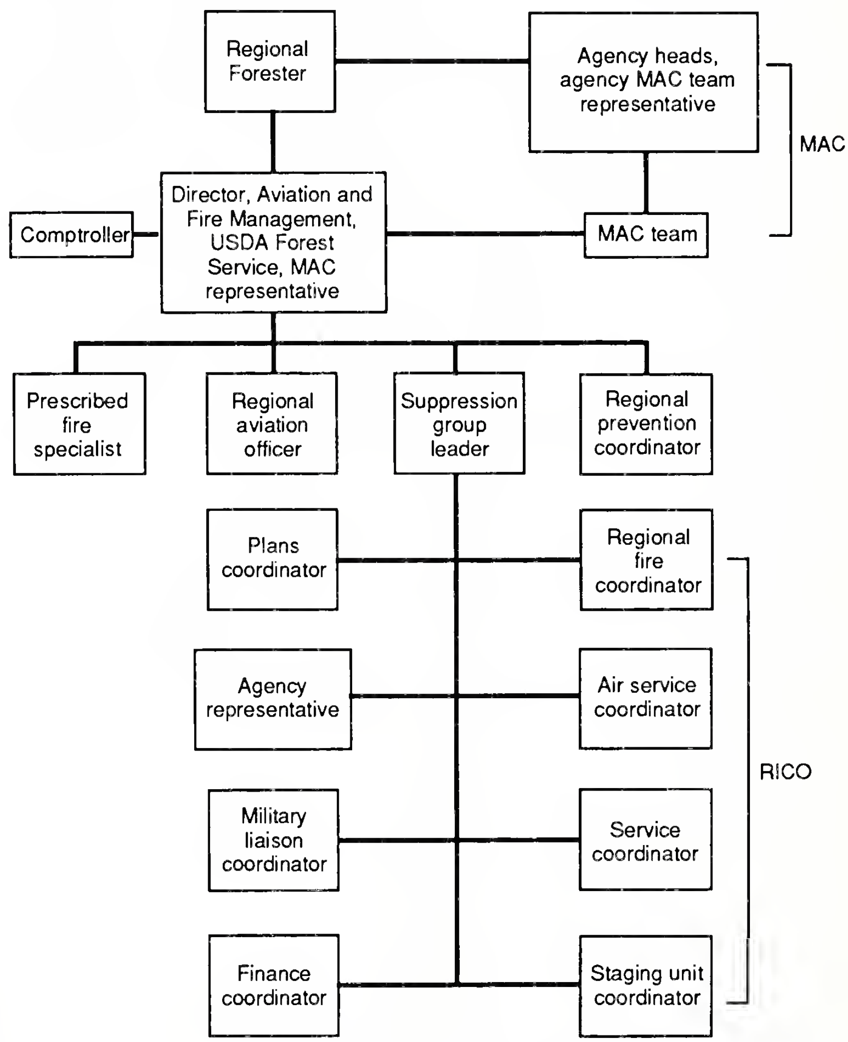

Figure 1—*Upper-level chain of command for the Regional Incident Coordinating Organization (RICO) and Multi-Agency Coordinating (MAC) team of Region 1.**

*Member organizations of the Northern Region RICO and MAC team: USDA Forest Service Region 1; USDI Montana State Office Bureau of Land Management, National Park Service, and Bureau of Indian Affairs; and Idaho and Montana Departments of State Lands. Member organizations of the Greater Yellowstone Area MAC team: USDA Forest Service Regions 1, 2, and 4; USDI National Park Service; and Idaho, Montana, and Wyoming Departments of State Lands.

filled and terminated quickly as needed. When a severe fire season seriously affects different agencies or fires are competing for resources within the Northern Region, the Multi-Agency Coordinating Team (MAC) is activated. The MAC team coordinates the interagency fire suppression decisionmaking process and relies heavily on the intelligence gathered by RICO.

The Fire Behavior Service Center and the Fire Behavior Analyst. Within RICO under the Plans Section, the Fire Behavior Service Center, operated by a fire behavior analyst (FBA) or qualified fire behavior specialist, may be activated if multiple project fires are occurring or high fire spread rates and fire intensities pose distinct threats to life, property, and natural resources (fig. 3). The service center may be staffed with additional specialists if the situation warrants extra assistance, either in the service center itself or in the field. A list of "on-call" fire behavior personnel and "trainees" is maintained by the service center to meet service center needs or special assignments on fire incidents. A minimum of two fire behavior specialists at the service center allows those individuals to alternate office and field responsibilities and keeps the service center office operated at all necessary times to issue reports and Fire Behavior Alerts as well as conduct periodic briefing sessions with the MAC team and RICO. Satellite service centers may be established for fire complexes or area commands, where additional specialized fire behavior analysis for the immediate area may be required.

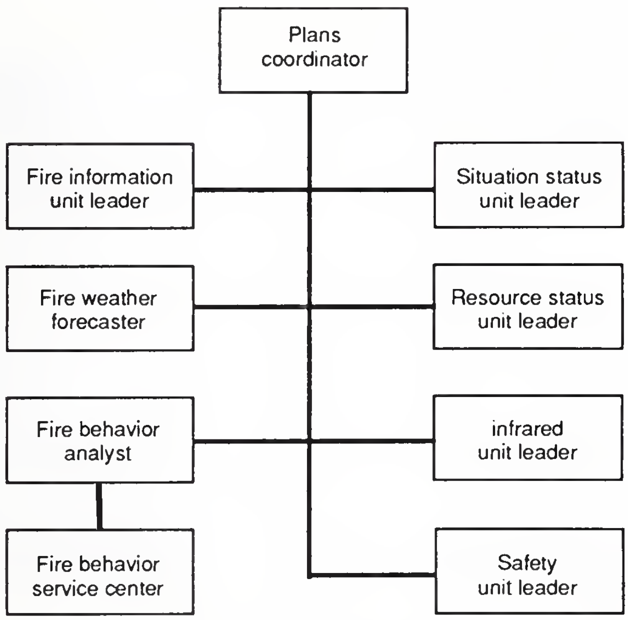

Figure 2—*Chain of command for the Regional Incident Coordinating Organization (RICO) plans coordinator position.*

Objectives. It is important to recognize that the purpose of the FBA's at the Fire Behavior Service Center is not to duplicate or replace the functions of FBA's on individual incidents. The staff at the service center provides support to FBA's on major fires and an overview of the regional fire behavior situation to the MAC team and RICO to assist in the establishment of priorities. Specific functions of the service center include the following:

- Map fire behavior severity zones in the region and determine order of priority.
- Update daily measurements from the region's Remote Automatic Weather Station (RAWS) network.
- Update burning indexes, energy release components, and 1000-hour fuel moisture for designated polygons or critical stations and graphically plot on a daily basis.
- Plot location and determine fire behavior potential of wilderness prescribed fires on a daily basis.
- Gather, plot, and display wildfire perimeter data for all project fires.
- Provide fire behavior input to the daily RICO Situation Report.
- Participate in regular briefings of the RICO, MAC team, media, and others.
- Brief on-call smokejumpers, incident FBA's, and overhead teams about the regional fire behavior situation.
- Schedule as-needed reconnaissance flights of major fires with video support.
- Maintain two-way communication with incident FBA's and provide

requested assistance on a case-by-case basis.

- Make on site fire behavior service visits to key fires in the region.
- Provide a pool of FBA's who are available to respond to the requests of incident FBA's to fulfill special assignments (for example, weather network monitoring, fuel model identification and mapping, fuel model verification, fuel moisture sampling, or BEHAVE terminal operation).

History of the Fire Behavior Service Center in the Northern Region

First years. The first application of the RICO Fire Behavior Service Center concept in the Northern Region was in 1984 with the aid of the Forest Service Intermountain Fire Sciences Laboratory. The laboratory provided personnel to collect fire behavior, fire weather, and fuel moisture data and aid in briefing sessions to key fire suppression planning personnel. The need for a service center during the 1984 fire season only lasted a week as the weather moderated and numerous project fires were brought under control. After the 1984 fire season, the organizational and data-collecting needs of the service center were evaluated and restructured to operate directly under the RICO plans coordinator.

These changes were implemented on July 15, 1985, when the RICO Fire Behavior Service Center was again activated with all functions located at the Aerial Fire Depot (AFD) in Missoula, MT. The service center functioned effectively within the organization, collecting needed fire behavior intelligence for suppression management decisions across the region until rain and snow started to fall 25 days later (Bushey and Goens 1985). While other RICO functions were deactivated, the service center remained to monitor weather and fuel conditions in case of a return to a warm, drying trend. After the season was over, only minor changes were found to be needed during a postfire season assessment of the service center's operations.

During 1986, the need to establish RICO was again necessary for a short period of time, but without the Fire Behavior Service Center. The 1987 fire season found the Northern Region with very dry fuel and hot, dry weather, but few ignitions, with the main area of fire activity in the Pacific Northwest. Thus, it was not necessary to activate RICO.

1988. In 1988, the Northern Region's fire season started early but the decision to activate RICO was not made until July 23. The Fire Behavior Service Center was activated and operational on July 26 and would remain on active duty until October 7. Other functions of RICO were deactivated on August 7, because of a reduction in the number of project-sized wildfires across the region. But because of the strong possibility of a future increase in fire activity, the physical facilities for RICO were maintained so they could be quickly reactivated if necessary. By August 10, an increase in fire danger ratings and the number of project fires resulted in RICO being brought back to full operational strength for what would end up being the "second half" of the fire season (Bushey 1989). During this later

Figure 3—*North Fork Fire (1988) in Yellowstone National Park moving toward community. When severe wildfires threaten people and communities, establishing a Fire Behavior Service Center can improve fire safety and fire management decisionmaking.*

period, another Fire Behavior Service Center was established at West Yellowstone, MT, to aid the fire suppression operations being conducted on 1.2 millon acres (485, 640 ha) by the Greater Yellowstone Area Command (GYAC). The GYAC satellite Fire Behavior Service Center was staffed with qualified personnel from offices in Washington, DC, the USDA Forest Service fire laboratories in Missoula, MT, and Macon, GA, and individuals released from other fires (fig. 4).

Fire Behavior Service Center Activities

Functions. The main purpose of the staff in the Fire Behavior Service Center is to gather, interpret, and disperse regional and interregional fire weather, fire danger indexes (Deeming et al. 1977), and fuel moisture data in terms of expected and potential fire behavior for the RICO and MAC team members and other coordinating groups. This information is presented in morning and afternoon briefing sessions to the RICO and MAC team group. Frequently, special briefing sessions are necessary during periods of critical interest or for visiting dignitaries and the public news media. It is important that the service center personnel have good presentation skills and can interpret their information in a precise manner using terminology and graphics understandable by the lay person (fig. 5).

Daily, or twice daily, Fire Behavior Reports, a part of the RICO Situation Report, are issued by electronic mail to all forest supervisor offices, fire dispatch offices, and incident command centers with computer facilities, summarizing the current fire behavior and fire weather situation on a synoptic scale generally larger than usually available to an incident FBA. These reports are included in the RICO Situation Report and update observed fire behavior trends; wilderness prescribed natural fire status; fire behavior safety precautions; and fire behavior advisories, watches, and warnings concerning regional trends or local phenomena. The Fire Behavior Report also incorporates short historical notes about other severe fire seasons comparable to the current situation. These historical notes create interest in the RICO Fire Behavior Report because of the expanded perspective and are commonly used by fire information officers (FIO). They are posted on fire camp bulletin boards, to ensure

Figure 5—*Fire Behavior Service Center's morning briefing session to the RICO, the MAC team, and the Governor of Montana and his staff.*

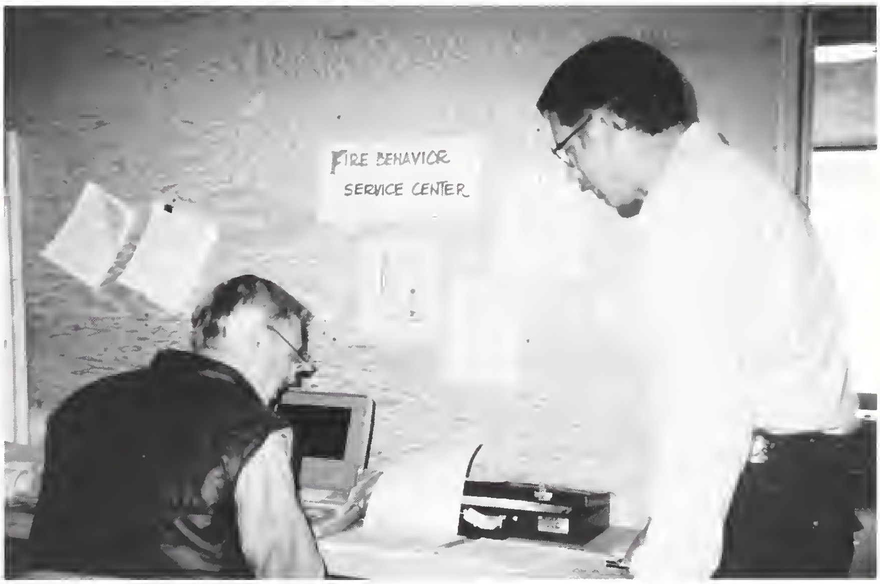

Figure 4—*Fire behavior specialists provided valuable assistance to Greater Yellowstone Area Command in West Yellowstone in 1988.*

an increased awareness of the current fire situation.

Greater Yellowstone Area Applications. The data collected are meant to support and complement fire behavior information requirements of FBA's on fire incidents as well as provide accurate knowledge to FIO's for public news releases. The two-way exchange of information between the service center and the incident FBA's is a critical interface to the successful function of the service center. This was clearly demonstrated on September 9, 1988, at the service center serving GYAC. Fire behavior that day had been very active over most areas of the Greater Yellowstone Area. By late afternoon, four-to-five massive convection columns were visible throughout the area. Two of the more active sites of burning were the northwest side of the North Fork Fire and the area near the Old Faithful Geyser complex. Late in the day, the North Fork Fire made a run northeasterly toward Bunsen Peak, threatening Yellowstone National Park's administrative site at Mammoth. Between 8 p.m. and midnight, there was a steady stream of requests for information concerning the ongoing fire situation such as the following:

- The FBA on Storm Fire to the east wanted to know what was occurring on the rest of the fire complex and why fire activity was relatively quiet on Storm.
- The FBA on Hellroaring Fire wanted to know why the Billings fire weather forecast was calling for snow the next day.
- The overhead team at Mammoth wanted information about the locations of fire fronts that were moving toward them that evening.
- Fire behavior information also was shared with the FBA at Mammoth regarding observed fire behavior measurements in sagebrush at Crandall.
- Information was also provided on the conditions that existed when fire burned over the Old Faithful Geyser complex on September 7.
- Assistance was furnished to provide a priority for Mammoth to receive infrared coverage during the night.

The Fire Behavior Service Center was in an advantageous position to provide this requested and critical information, because it had been gathering and dispersing fire behavior intelligence on an areawide basis during the severe fire season.

Process. To achieve objectives designed for the Fire Behavior Service Center, the service center obtains updates of weather measurements from the established network of RAWS (Warren and Vance 1981). The RAWS are used to monitor the dynamic nature of fuel moistures, temperatures, relative humidities, and wind speeds for regional or intraregional (area polygon with similar fuel, weather, and topographical conditions) trends. Observed trends are compared with previous severe fire seasons. The RAWS data and National Weather Service (NWS) information are used to track significant weather patterns that could affect fire behavior. Fire behavior analysts at the service center work closely with the local NWS fire weather office. Fire Weather Reports issued by the NWS from across the Western United States are monitored for changing weather patterns in other Forest Service regions that may interact with ongoing fires in the Northern Region. Current fire danger indexes, in particular the energy release component, are graphed for key stations and trends compared with previous severe fire seasons.

The relative values for the indexes are also mapped daily by polygon within the Northern Region (Burgan and Hartford 1988) (figs. 6, 7, and 8). This system of displaying fire behavior-related information by geographic polygons within the Northern Region was termed ALERT (Anticipated Level of Energy Release Timing). The system uses such indicators as the energy release component, 1000-hour fuel moisture, and burning index that identify areas with severe fire behavior potential. This information can be used as an aid in pre-positioning fire suppression forces and equipment, requesting contingency funds, and coordinating wilderness fire management programs. By using predicted weather inputs to the National Fire Danger Rating System, ALERT can be used to anticipate the future timing of energy release levels. ALERT was a fire research development following the evaluation of the 1984 service center operation and has since become available on a national basis. Fire danger status in other Western regions is also monitored to keep track of the potential need for the shifting of fire suppression resources. These last activities were particularly important during 1988 when for a short time we entered into a multiregional severe fire situation involving the Forest Service's Northern, Rocky Mountain, Intermountain, Pacific Southwest, and Pacific North-

west Regions (Regions 1, 2, 4, 5, and 6, respectively) (Bushey 1989).

Close monitoring of precipitation events and patterns across the region is a regular duty and done in association with evaluations of changing fuel moisture and fire danger trends. Nighttime 1-hour fuel moisture recovery from either precipitation or increased relative humidity is tracked each morning across the region and made available to incident FBA's in the morning Fire Behavior Report. Soil moisture (from RAWS measurements and drought indexes) are periodically checked as a tool in evaluating current and near future fuel moisture trends, especially when soil moisture levels begin to approach the 1000-hour fuel moisture contents.

In connection with these evaluations of current weather and fire danger conditions, real-time use is made of data collected by other instruments such as the lightning detection network provided by ALDS (Automatic Lightning Detection System) (German 1988), radiosondes, and weather radar. The ALDS is used to track strong thunderstorm cell development and, in conjunction with NWS radar, to distinguish between dry and wet cells. Fire dispatch offices and fire incidents in the vicinity of the storm tracks are alerted by electronic mail and telephone concerning the apparent strength of the cell, the amount of lightning activity, and the direction and speed the cell is traveling.

Alerts and Warnings. Fire Behavior Alerts to fire dispatch offices give important advanced notice of potential starts along storm tracks, particularly dry fuel types,

Figure 6—*Examples of maps used in the Northern Region to depict by polygon (top to bottom) the relative seasonal energy release component, relative seasonal burning index, and 1000-hour fuel moisture (July 22, 1988).*

and timely notification of fire crews already on fire incidents with confirmed data of approaching thunderstorms with strong downdrafts. For example, fire crews on the 1988 Combination Fire on the Deerlodge National Forest, a new lightning-caused ignition actively being suppressed by both fire crews and smokejumpers, were able to retreat to safety zones after a 45-minute advance warning to the local interagency fire dispatch office informed them of a thunderstorm developing on the other side of the Sapphire Mountain range. This storm crossed the fire and caused the fire to rapidly grow to over 5,700 acres (2,307 ha). No injuries were reported and no fire shelters deployed.

Radiosonde readings from Western NWS and Canadian Weather Service stations are used in tracking high-elevation atmospheric features that may have significant impact on ongoing fires or future regional fire danger. These atmospheric features such as subsidence inversions, strong winds, and reverse wind profiles (Byram 1954, Rothermel and Gorski 1987, Bushey 1990, Bushey in preparation), and the upper-level freezing zone in mountainous terrain are very difficult for an FBA on a fire incident to monitor without the assistance of a fire weather forecaster and are sometimes best viewed from a regional scale rather than a single point on the landscape. Fire Behavior Watches and Fire Behavior Warnings have been issued from the Fire Behavior Service Center concerning atmospheric features of these types for their potential, or known, ongoing effect on either wildfire behavior or regional scale fuel beds. Upper-level wind speeds and direction from these atmospheric soundings are also important as input into computer projections by the service center to analyze convection column orientation, dispersion, and impact on sensitive receptor sites by particulates and reduction in visibility. Fire lookouts and helicopter pilots can act as an important source of information in supplementing data from the widely scattered, twice daily readings obtained from the radiosonde atmospheric profiles. Even if certain weather or fire behavior phenomena are not occurring on a particular fire incident, the FBA is in a better position to make predictions if they are informed of the potential and know that these events may be taking place elsewhere under similar fire conditions.

The active monitoring of environmental conditions and ongoing fire behavior as well as a knowledge of historical extreme fire behavior patterns allows for the advanced warning of the potential for significant wildfire events. These activities by the Fire Behavior Service Center

How We Stay Informed

RICO Situation Report: A twice-a-day report issued by the RICO and the MAC group to all agency offices and fire camps via FIRENET over the Data General computer system. These situation reports update the Northern Region's wildfire and wilderness prescribed natural fire activity, current resource situation, the Fire Weather Report, and the Fire Behavior Report.

Fire Behavior Report: A report issued by the Fire Behavior Service Center, usually within the RICO Situation Report, summarizing the current regional fuel moisture situation, expected 24-hour-predicted-fuel-moisture trends, and potential fire behavior based on synoptic scale weather information for the period. The report also updates wilderness prescribed natural fire status and frequently includes information from historical fire behavior and fire weather for the date and safety notes that apply to the current fire behavior situation.

Fire Behavior Watch: Message sent by the Fire Behavior Service Center (frequently part of the Fire Behavior Report) to all agency offices and fire camps connected by FIRENET on the Data General computer system. The watch reports the potential for erratic or severe fire behavior from anticipated changes in fuel or weather conditions during the *next 48-hour period.*

Fire Behavior Warning: Message sent by the Fire Behavior Service Center (frequently part of the Fire Behavior Report) to all agency offices and fire camps connected by FIRENET on the Data General computer system. This warning reports potential erratic or severe fire behavior from anticipated changes in fuel or weather conditions during the *next 24-hour period.*

Fire Behavior Alert: A fire behavior or fire safety message, preceding or following a Fire Behavior Warning, sent by the Fire Behavior Service Center to specific agency offices and fire camps, via the Data General computer system and followed up by telephone communication, concerning dangerous conditions *observed* on an ongoing fire that may be applicable to other fires within the same geographic region or similar fuel type.

allowed for early warnings of potential extreme fire behavior events to occur in early September 1988. These warnings allowed for community and fire camp evacuation plans to be developed and implemented in connection with local sheriff departments and disaster assistance organizations. The information was utilized by the Governor's staff to execute recreational restrictions throughout the State of Montana and to set back the opening date of upland gamebird hunting season. Neither decision was popular in a State where the public tends to be independent-minded and protective of their outdoor recreation, but both were important in successfully restricting the potential sources of new wildfire ignitions during a period of extreme fire danger and limited additional fire suppression resources. When the predicted extreme fire behavior arrived on September 6 and remained active in the region until September 9 (the first warnings were issued on September 2) in the form of a dry-cold front with extreme winds and a surfacing jet stream, the fire suppression organizations were as prepared as possible. No lives were lost because of the fire behavior even though numerous fire fronts ran for miles with the wind, sometimes through local communities in their paths (Bushey 1989, Bushey 1990, Bushey in preparation). The Canyon Creek Fire, for example, was one of several that had been targeted by the service center as susceptible to extreme fire behavior. This fire during one burning period, starting the afternoon of September 6, ran for 21 miles (34 km) out of the mountains of the Scapegoat Wilderness onto the plains of the northern Rocky Mountains, burning 117,330 acres (47,483 ha) with conifer crown fire rates-of-spread up to 9 miles per hour (15 km/h) (Bushey in preparation).

Other Services. In addition to the monitoring and reporting of environmental conditions and fire behavior, the Fire Behavior Service Center has also taken on many other varied duties. These have included the briefing of incoming overhead teams, smokejumpers, and fire crews passing through the Aerial Fire Depot about the current fire behavior and fire weather situation across the region and at the incident to which they are headed. The service center is a good place for an incoming FBA to get "oriented" about a new incident. Service center personnel have also been involved in the active monitoring, fire behavior prediction, and periodic perimeter mapping of ongoing prescribed natural fires during the wildfire season. At the end of the fire season, service center personnel are suitable individuals for documentation of either the fire season or particular unusual incidents because of their access to the necessary information. This can be expressly important with incidents that may experience future legal problems resulting from injuries or damage.

Conclusion

The Fire Behavior Service Center concept has proved useful in the Northern Region and has on several occasions been referred to as possibly having saved firefighting personnel from injury. To keep overhead and crews aware of the potential for increased dangers in an already dangerous occupation, especially when their alertness may have been dulled after being on the fireline for extended periods during severe fire seasons, is the ultimate responsibility of all FBA's. Thus, the Fire Behavior Service Center adds a significant new dimension in the collection, analysis, and distribution of fire behavior information on a regional or areawide basis that can materially assist the efforts of RICO, the MAC team, and incident overhead teams. Implementing the concept can return important dividends to fireline safety and fire management programs. ■

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The Range Finder

The way I use the Osborne Firefinder to plot *exact* distances from lookouts to fires or unknown landmarks requires absolutely no mental calculation and is error free if used within its limitations. This simple system and its limitations are described below.

Procedure

- Place the sliding peep hole sight and the top crosshairs on the base of a smoke or an unknown landmark.
- Keep your eye lined up behind the peep hole sight and crosshairs as you slowly rotate the sight bearing ring.
- Stop rotating the ring when you intersect a known landmark such as a road, river, meadow, clearcut, ridge base, butte base.
- Note the position of this landmark on the distance tape.
- Rotate the sight bearing ring back to the original azimuth and use this position on the distance tape to plot the *exact* distance of the fire or landmark from your lookout.

(*Hint:* Try to keep both eyes open during the second and third steps. It isn't vital to the procedure, but will help user see small landmarks that are obscured by the crosshairs.)

Best Use and Limitation

The fire or unknown landmark referred to in the first step and the known landmark in the third must be at identical elevations.

The range finder is most useful in areas where landmarks are poor or unavailable. It works best at lookouts that are significantly higher than the surrounding area, but is efficient at all lookouts that include some flat terrain in their seen areas.

A moderate slope can also be accommodated once the lookout has a working knowledge of the procedure. For example, a smoke situated halfway between two known landmarks (for instance roads) is on a gentle slope perpendicular to your line of sight. The higher road on the right sights in at 4 inches in the distance tape, and the lower road on the left sights in at 5 inches on the distance tape. Using the average distance (4½ inches) of these two landmarks, plot the fire. Should the distance between known and unknown landmarks be different than the example above, different ratios will be necessary. Accuracy will sometimes vary with this alteration of the range finder. ■

Jim Shotwell, *Odell Butte lookout, Crescent Ranger District, Deschutes National Forest, Crescent, OR*

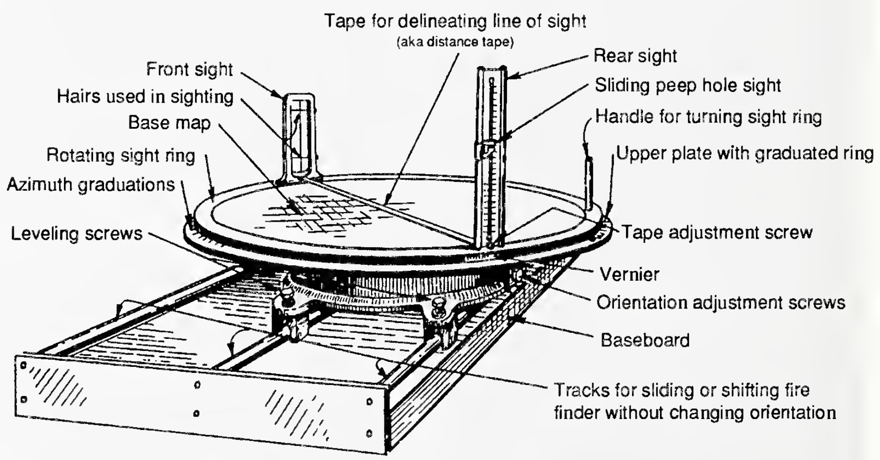

Diagram of the Osborne Firefinder.

Fire Training[1]

For the first time in 6 years (fire season of 1989) I didn't go on any wildfires. I was ready though. I trained and prepared for this fire season better than any previous. I was in the best shape of my life.

How did I do it? The first thing I did was lose 20 pounds. I did that by giving up the things I loved; pizza, potatoes of all kinds, pasta, beef, pork, lamb, chili, corn, crackers, white bread, fried anything, chips, cookies, and ice cream. I ate so much poultry and seafood I felt like the "chicken of the sea." But no sacrifice would be too great; I was going to be in the best shape of my firefighting career.

Then I worked on my endurance. I have two sons under 6 years of age at home so I decided to do everything they did. When they ran, I ran. When they walked, I walked. When they slept, I slept. I lasted 3 days. After that, all I could do was sleep, no matter what they were doing.

But I got my stamina up. My weight was down and my strength increased, but I felt I was ignoring an important point. I was missing a key element. Then while reading "The Goat Roper News," it slapped me between the eyes like the free end of a pigging string. I was omitting mental preparation.

I needed a program that toughened myself up mentally—something that would make me immune to hurry-up-and-wait, the ridiculous decisions by know-nothing overhead, and the Forest Service-way-is-the-only-way attitude. I had to devise my own program since no one had ever thought of such a thing.

So I developed the Get Mentally Tough for Fire Fitness Program or GMTFFP. If successful, I could market it and be some sort of yuppie guru consultant making big bucks. As a consultant, I would stroke my chin, nod sagely whenever someone asked me a question, and never give them a straight answer. But first I had to try the program on myself. I figured a week would be plenty.

On Monday I went to work as usual, but with a twist. The alarm clock woke me at 4:15 a.m. For breakfast, I ate some halfway defrosted frozen pancakes off the flimsiest paper plates I could find. I used a plastic fork typical of fire camps so it broke as I worked up my first mouthful. I sat at my patio picnic table in the predawn dark. I turned on a fan to blow ashes from the Weber barbeque across the picnic table. Then nourished, I left for work.

I walked to work carrying a shovel and a fifty-pound pack. In the pack were rocks and underneath the rocks was my lunch in a paper sack. I peeled the plastic off my flat sandwich and dropped it in the dirt before I ate it. I made sure the meal was too salty. I drank no cold water during the time I was on the GMTFFP. I drank water specifically heated to 105 °F and laced with quinine to get that sour fire camp taste.

After work I rode home in the trunk of a neighbor's car. My wife had fried a chicken for supper. I took my supper on another flimsy paper plate and poured the leftover grease from the skillet on my portion to give it that fire camp flavor. Again I sat at the picnic table. I turned on the fan again and set a full garbage can next to it for an extra touch.

I had 50 transients come to my house for a shower. I stood at the end of the line to make sure all the hot water was used up by the time I got there. I used two hefty paper towels to dry off when I got done.

That night I slept on the sidewalk underneath the street light. To make it more realistic, I put some gravel under the sleeping bag. I found a cassette tape of motor and generator noises to play on my Walkman as I dozed off. I had a neighborhood kid with a loud car stereo drive slowly by. Another neighbor woke me at intervals asking if this was the Mt. Hood crew. The area dogs were an unplanned but handy irritant, especially when one woke me with a warm wet feeling.

I varied this routine every day by the addition of different events. One day I slid down a rope to make my hands sore. On another, I walked to work barefoot. I trapped a squirrel in my red pack and had him chew up my underwear. I put a rock in my shoe. I had a street person talk to me in a loud voice for 5 hours about the cosmic significance of mayonnaise.

I had a guy in a faded green uniform pop up randomly with the thought of the day—things like this:

- "We didn't bring you here to think."
- "You can't get new batteries for your head light until you bring in the dead ones."
- "Not until you get this form signed by the IC, all the chiefs, and bring a note from your mother."
- "It's a great idea but don't do it again unless the IC clears it."
- "It's logical, clear, and concise. That's the reason we won't use it."

I got to admit GMTFFP worked swell. After a week, I had experienced all the mental situations of a wildfire. I was ready. I had my physical fitness up. I was mentally tough. The problem was I had absolutely no desire to fight wildfire so I didn't.

Maybe GMTFFP worked too well. ■

J. Howard Parman, *forester, Bureau of Land Management, Eugene District, Eugene, OR*

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[1]Reprinted from the Oklahoma Forester's regular column in "The Sidetrack," Bureau of Land Management, Eugene, OR, District newsletter, October 1989.

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